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THE JOURNAL OF ENGINEERING EDUCATION

Published by THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

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VOL. XXIV., NO. 2 | OCTOBER, 1933 | Subscription Price $3.00 per year
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THE JOURNAL OF ENGINEERING EDUCATION

Published by the Society for the Promotion of Engineering Education

Published under the Supervision of the Publication Committee.
W. E. Wickenden, R. A. Seaton, F. L. Bishop, Editor, University of Pittsburgh.
Published at Prince and Lemon Sts., Lancaster, Pa.

Entered as second-class matter at the Post Office at Lancaster, Pa., under the Act of March 3, 1870.

New Series
Vol. XXIV, No. 2. OCTOBER, 1933 Subscription Price, $3.00 per year. Single Copies, 50 cents.

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FIRST CALL FOR ITHACA

By W. E. WICKENDEN, *President of the Society*

Ithaca will be the Mecca to which engineering educators will make their pilgrimage in June, 1934. In the sentimental war days it used to be said that every man had two countries—his own and France. Most of us feel that way about his own college and Cornell. Nature and tradition combine to give it an appeal which few seats of engineering education rival and none surpass.

Your Program Committee is planning something more than just another convention. Last June our minds were turned to the founding of the Society in Chicago, forty years before. In 1934 it will be fitting to turn to the future. One by one the early leaders of the Society are laying down their active duties. At Ithaca we hope to rally our leaders of ten years hence. Many of them today are rising assistant professors, the sort of men to whom are usually entrusted the building up of teaching and research in the newer phases of engineering—fluid mechanics, vibrational stresses, photo-elasticity, the experimental analysis of structures, electronics, applied acoustics, the X-Ray analysis of metals, air conditioning, the esthetics of engineering design, to take a random sampling.

A lot of fine original work is going on in many a classroom and laboratory in semi-isolation. How much more fruitful it might be if it could be shared with others working on similar projects. Here is a task waiting for the Society. What is being planned for the Ithaca meeting is a group of intimate conferences, each confined to problems of teaching and research in some specific field and emphasizing new developments. These conferences will occupy the first two and a half days, leaving an equal period for the convention proper. As far as practicable, the planning and conduct of these conferences will be in the hands of our younger men, not yet prominent in the Society. Deans, presidents, department heads, council members and the old guard generally will be welcome to attend, but it will be the young guard's show.

COMPARISON OF PRESENT MECHANICAL ENGINEERING CURRICULA WITH THOSE OF 1908 *

By WM. T. MAGRUDER,

The Ohio State University, Columbus, Ohio

Since the final report of the Board of Investigation and Coördination of the S. P. E. E. was received, much study has been devoted to the conclusions it presented relative to the present curricula of our Colleges of Engineering, and to the wisdom and possibility of the colleges changing their curricula so as to conform more nearly to the suggestions of the Board. There seems to have been much self-examination on the subject. At first there was a reaction against a uniform and stereotyped curriculum in any one branch of the profession for all colleges. This point of view still abounds and may be growing, as the varieties of courses, options, and degrees now offered are greater than ever before.

A supplement to the Wickenden report has come from the alumni. In fact, the curriculum of one institution has been changed and revamped more times than one in the last five years at the request of the Alumni Committee and the present curriculum in mechanical engineering is scheduled for another "complete rearrangement of courses" within the next year or two, although it now has a great variety of options.

Different alumni would like to have their colleges add to their undergraduate curricula all the various subjects that they have been called upon to study since they left college with a B.S. degree and these subjects are very numerous. However, there is no uniformity of opinion as to the suggested subjects which should be added. The colleges naturally desire to give their students the very best intellectual and technical equipment for their profession that the time available will permit and which the students feel that they can spend in that way. Faculties have been conservative in their changes, and have not abandoned all the old courses of study just because some alumnus ten years after graduation is sorry that he did not have a course while he was in college, which he has recently been called upon to use, or which had not been heard of when he was in college. Neither are engineering college faculties

* Presented at the 40th anniversary meeting, S. P. E. E., Chicago, Ill., June 26–30, 1933.

standpatters. While they are not all from Missouri, they are willing to do some experimenting, even at the expense of the student body and themselves.

More recently, another element has entered into the situation, due to the inadequate finances of the institutions with which to continue elective courses that do not fill, and to add curricula and special options because other colleges are offering them. This is particularly true of the more expensive courses of study which require costly laboratory equipments which are used but seldom and for but a few hours each year. The very great curtailment of the budgets of our private, state, and city colleges which are now going into effect will cause a demand for a great decrease in the number of courses offered and economic modifications of the engineering curricula. For these reasons, college executives have not been slow to welcome decreases in such offerings, and this is necessitating the rearrangement of the curricula of several of our colleges, increasing classroom courses and decreasing laboratory courses, and other colleges may yet feel the necessity of keeping within financial as well as intellectual bounds.

In the last five years, there has been an increasing demand by students for further education and training than that received in the normal four-year engineering curricula and this has caused the colleges to offer at first a few additional courses of study, then a year of regular graduate study for a master's degree, or for a second baccalaureate degree, and now an increasing number of colleges and technical schools are offering engineering graduates their choice not only of real graduate studies but of several (six) degrees (M.S., M.S.E., M.E., D.E., D.S., Ph.D.). The question has been raised in this connection as to whether a master's degree should be awarded for just additional study, chiefly, if not solely, of undergraduate courses, rather than for courses of advanced study; also, if a master's degree should be awarded to a student who shows no leadership and no originality and only hangs around his undergraduate college, plays at research, and is possibly afraid to let go of his dear alma mater's apron strings and get out into the industrial world. Inability to get suitable employment has increased the demands of the recent graduates for "additional" and graduate work. The need for further study of a more advanced type has been emphasized within the last few years by the demand of employers for graduates who have had one or more years of additional study and by their willingness to start such a young engineer at a slightly higher rate of pay. While the courses of study offered for graduate degrees might form an interesting subject of investigation, time will not permit its inclusion in the present study of undergraduate mechanical engineering curricula.

Combined curricula in arts, commerce, and engineering are very generally offered but to few takers. Five-year curricula have never been popular with either faculties or students and have caused several good colleges to decrease greatly their enrollments. The American youth demands a degree of some kind at the end of four years of college work. It is thought that only by the concerted action of a considerable number of our leading engineering colleges in adopting a five-year curriculum leading to a bachelor's degree could this accepted practice of academic America be changed.

But the persistent academic mind is not satisfied with such decisions, and, not being able to get what it wants, seeks a compromise between a strictly engineering curriculum founded on the fundamental subjects of English, mathematics, chemistry, physics, and drawing, and one into which has been injected as many and much of the arts college subjects as the student can be induced to take. Recent trends in curriculum-building have been in this direction. But to add academic subjects to engineering curricula already overloaded, as a rule, means that some of the older and more common subjects of study must be omitted, or at least whittled down to a minimum. Both subtraction and total elimination have been practiced in recent years in making the changes that have overtaken the curricula of most engineering colleges. The processes of evolution have been found to apply to engineering education, just as to other human activities, and it does not require the instinct of a gambler to decide that that course of study which fits the greatest number of students and embryo engineers is the most likely to survive the present process of "natural selection."

Having made a study of the mechanical engineering curricula of twenty-six of our larger engineering colleges some 25 years ago and reported the results of the investigation to the Society for the Promotion of Engineering Education at its Detroit Meeting in 1908, the Department of Mechanical Engineering of The Ohio State University instructed a committee of its members (W. T. Magruder, A. I. Brown, and K. W. Stinson) to study the subject of what changes should be made in the near future in the mechanical engineering curriculum of The Ohio State University. The following study is one of the results of that assignment.

It was evident from the start that the curricula of all of the prominent engineering colleges of the country could not be included in the survey as the time available forbade it, and so some nineteen typical colleges, scattered in location from the Atlantic to the Pacific Ocean, having the largest enrollments of students and the greatest variety of courses of study included in their requirements for a bachelor's degree in mechanical engineering, were selected. The curricula of certain colleges were included because of certain

unique features, due to powerful personalities in their faculties, and as being suggestive of present trends and possibilities. Comparisons with the curricula of these same colleges 25 years ago have been instructive and show what courses of study have been eliminated or shortened, and what studies have been added.

Another line of study has been what is the composite or average number of hours devoted to kindred subjects considered as collective groups. For example, how much time is supposed to be spent in the study of chemistry, mathematics, and physics, each collectively, as well as how the teaching of any one of them is divided into clock-hours of lectures, classroom recitations, laboratory work, and preparation.

When the work was begun in the Winter of 1932, copies of the latest catalogs were obtained from which to gather facts as to the curricula and courses of study as printed. Late in the Spring of 1932, the new bulletins, giving the curricula for 1932–1933, became available and some of the work was revised. It was found that of the nineteen colleges considered, seven were operated on the two-semester plan (Columbia was operated on the two-session plan), six were on the two-term plan, two were on the three-term plan, and three were on the three-quarter division of the college year; and that six had additional supplementary practice and summer terms or sessions at the college or in industry, or both; that the terms, semesters, sessions, and quarters of the college year were of unequal net teaching lengths in several colleges, and were closed by examination periods ranging from three and a half days at Ohio State to two weeks at the Massachusetts Institute of Technology; that the bulletins did not always state how much time was given to lecture, recitation, practice, and to preparation; and that it was correspondingly difficult to determine with accuracy just how much net time was devoted to lectures, recitations, practice, and to preparation, so as to determine the total numbers of hours devoted to a subject or to the subjects of a particular group or class, such as mathematics, physics, etc., and to the total number of clock-hours of time which the student is expected to spend in obtaining his degree in four years of study, including none, one, two, or three summers of work. Most of the colleges studied use the "credit-hour" or "credit" as a unit of time and count it as either one hour of lecture or recitation and two hours of preparation, on the average, or as two hours of practice where some outside work is expected in the writing up of notes. A number of the colleges make no distinction between lectures and recitations. The Massachusetts Institute of Technology uses the term "credit unit" and defines it as fifteen clock-hours of work per week, or one clock-hour of work for the fifteen net weeks of a term. Columbia

uses (credit) "points," which is apparently the same as a credit hour. The California Institute of Technology uses (credit) "units" which are really clock-hours of a student's time per week for one term of eleven or twelve weeks. The Case School of Applied Science until now used the term "hour" and meant actual clock-hours of classroom work, laboratory, or preparation, and gave the number of weeks spent on each subject. About 51 clock-hours of total time is counted as a credit hour at Case. It is now changing its schedule to the credit-hour basis of assignment. At Stevens Institute of Technology only classroom periods per week and the hours of laboratory, shop, drafting, or conferences are listed and credits and credit hours are not mentioned. The variation of the semester from fifteen to seventeen weeks and the quarter from ten to twelve weeks of teaching is a further difficulty encountered in evaluating credit hours, points, and units of different lengths of time. An attempt was made to reduce these various units to "credit hours" and to mean thereby three clock-hours of a student's time, unless otherwise stated, and thus to bring all the curricula to the same unit of measurement, namely, the clock-hour.

In evaluating the total time expected of a student to be spent in obtaining his first degree in mechanical engineering much possibility of error is due to the amounts of time expected of the students in the preparation of work. At Ohio State, and quite generally elsewhere, a credit hour calls, on the average, for three clock-hours of a student's time. It may be divided into one hour of classroom work and two hours of preparation, or two hours of laboratory work and one hour of note-writing, or it may all be used in the laboratory work and no outside work expected of the student. At one institution only an hour of previous preparation is expected for each classroom period. At another, the times expected to be spent by the student are carefully specified and vary from nothing to three hours of preparation for each lecture or recitation. Some instructors think that it is absurd to assume that students spend from fifty to sixty hours per week on their required university work, on the average, or two hours in the preparation of the average classroom assignment, and that statistics which seem to prove this statement are made to placate the instructor, and are valueless as evidence. The writer doubts the correctness of this statement and asks for acceptable proof.

In July, 1932, neostyled blank forms giving the numbers of the courses, the numbers of points, credits, or units, the hours per week devoted to lecture, recitation, practice, and preparation of each course in the latest known curriculum in mechanical engineering were sent to the chairman of the department of the college

concerned with the request to have the list checked up and returned. The prompt and kindly coöperation of these professors was greatly appreciated and the writer's personal thanks is extended to each of them and their assistants for the service rendered.

It is hoped that the reported data will be found to be free from gross errors and as free from inaccuracies as is humanly possible.

As some institutions do not allow or give any credit for such subjects as assemblies, conferences, physical education, military science, and possibly other subjects, and because of the different net lengths of the terms, quarters, semesters, and sessions, and of the college year, it is thought that any conclusions based on credits, credit hours, points, units, and the like may be misleading unless these other data are taken into consideration. Reference is therefore made to the columns giving the total net numbers of hours of lectures, recitations, practice, preparation, and to the total numbers of clock-hours given either to a particular subject, or to a group of kindred subjects, as being probably the fairest unit of measurement and of comparison of the different curricula.

In grouping subjects together, it was found that some latitude had to be given, and that one could not classify them solely by the department in which they are given at an institution. For example, mechanics is sometimes taught in one department and sometimes in another, depending upon the personnel of the departments and the facilities which are available.

At some institutions, mechanical engineering laboratory work is listed separately while at others it is included in the laboratory work of a book course, such as "heat engines," as is the accepted practice in chemistry. Hence, the figures given for mechanical engineering laboratory courses should be added to those in mechanical engineering subjects to make a correct comparison.

Because of these many differences in practice in counting credits for work done by students, it was thought that the fairest method was to compare the summaries of total clock-hours devoted to lectures, recitations, practice, and preparation at the different institutions. Such a comparison is made in the accompanying tabulation for the twenty groups of subjects at the nineteen institutions. Those who prefer to use the other units may do so.

Referring to the accompanying tabulations, the following statements can be made as to our present curricula in mechanical engineering and comparisons made with the curricula of 25 years ago.

Entrance Examinations

The practice of holding entrance examinations in mathematics, physics, chemistry, and English seems to be returning. The penalties for not passing them vary from non-admission to being remitted to non-credit preparatory classes for a term or semester and sometimes with an extra fee to be paid and without being permitted to take descriptive geometry at the scheduled time, and the necessity of being required to make up in the summer term all such freshman deficiencies before beginning the work of the second year.

Languages

Most colleges require a minimum of one, two, or three (Cornell and M. I. T.) units of one foreign language or two units in each of two foreign languages for admission, and if not offered for admission, the deficiency must be made up during the freshman year in college. Case does not admit an applicant who has had no foreign language.

Just as "Greek as a fetich" was taken out of the standard A.B. curriculum some fifty years ago, so foreign languages have been taken out of the engineering curricula of even our best colleges in more recent years. At most colleges, foreign language is an elective subject for three, four, or five recitations a week for one or more quarters, terms, or semesters. Only at the Worcester Polytechnic Institute is German, French, or Spanish required after admission, and that for 192 hours of recitations, whereas twelve of these nineteen colleges required some foreign language in college in 1908 and averaged 130 recitations. The present trend seems to be towards requiring no foreign language either for admission to, or for graduation from, the engineering college. While the argument for the necessity for a knowledge of foreign languages is no longer tenable, as the large majority of engineering instructors, as well as of engineers, get along without their use, their value as training in languages cannot be denied. It is hoped that at least two high-school entrance units in one foreign language, or the equivalent in college credits, may be continued to be required as a minimum for graduation from a college of engineering. It is feared that the trend is in the other direction, although two years of study of a foreign language is required for graduation from an accredited high school in the State of New York.

English is required at Case for five and at Stevens for seven of their eight terms. Cincinnati requires English for fourteen terms. Cornell requires no time to be spent on any language while in College. The amount of time devoted to English varies from none at Cornell and 108 total hours at California, to 612 hours at

Purdue (English, three hours a week for two years). Less time is now being spent on English as a branch of literature and more on it as an accurate tool of expression in general conversation and in the writing of letters, reports, and specifications. Summer courses in required reading of general literature seem to have vanished from the engineering curricula, as the popular five-cent and fifteen-cent periodicals seem to meet the present desires in that direction. The objections to such courses were the trouble and labor incident to doing the reading and to evaluating and crediting the reports.

Mathematics

The entrance requirements vary from one and one-half units each of algebra and geometry at Purdue to two units of algebra, 1½ units of geometry, and a half unit of trigonometry at The California Institute of Technology, Cornell, and at The Massachusetts Institute of Technology, and taken by examination at the last in order to enter. At Case, applicants for admission who "offer trigonometry and at least two units of algebra and who also do well on the placement test are allowed to start their college mathematics with analytic geometry and are allowed to take certain electives later in the course." The variations in the entrance requirements in mathematics account in part for the variations in the times devoted to college mathematics from a minimum of 450 total hours at Cornell (150 recitations; 182 in 1908) to a maximum of 990 hours at Ohio State. Purdue required 396 recitations in 1908; now 306. Purdue, Illinois, Johns Hopkins, and Case require 918 and Worcester 928 clock-hours. The average is now 767 total hours, whereas it was 823 total clock-hours (274.4 lectures and recitations) in 1908.

Several colleges have reduced their requirements in mathematics within the last year or two, notably Michigan from 20 to 18 semester hours in 1931–32 and now to 16 hours (four hours for four semesters). Purdue and Wisconsin have decreased it from five hours to four hours for one year in calculus, and Illinois to five plus three making eighteen semester credit hours given to mathematics. At California Institute of Technology, no student is admitted whose preparation does not include 1½ units of algebra, one unit of geometry and a half unit of trigonometry, and one unit of physics. Being a privately-endowed institution, it can enforce its rules and limit its entering class to 160 persons.

Entrance examinations and placement tests in mathematics are being more generally considered with the idea of keeping out of college classes those students who are not prepared for the work. The unpleasant part is what to do with the boy who proves that he

is not prepared to carry the work unless a "prep" course or a coaching class is available in the college, or a high school is nearby. Should his entrance credit be revoked?

It has been recommended that a thorough review and drill in arithmetic, algebra, and geometry be given in the last term of the high-school curriculum.

More use is being made of differential equations, and courses are beginning to be offered in "Applied Mathematics" and given by experienced mathematical engineers.

Chemistry

Under this subject are included courses of study on metallurgy, metallography, physical, industrial, and power-plant chemistry, and a few kindred subjects, as well as freshman chemistry. The total amounts of times devoted to the subjects of this group now vary from 306 at Purdue, 336 at Michigan and Worcester to maxima of over 600 hours at Stevens because of time given to quantitative analysis and to industrial chemistry, and at Columbia because of time given to metallurgical subjects, to a maximum of 892 hours at Case, including time devoted to metallurgy and metallography and power-plant chemistry. At Ohio State, 528 total hours are given to freshman chemistry and to metallurgy. The average is now 511 total hours. In 1908 it was about 532 total hours.

Freshman chemistry now carries a minimum of five semester hours at Michigan, and $3 + 4$ semester credit hours at Worcester to maxima of ten semester credit hours at several colleges.

If chemistry, like physics, were required for admission as at California, California Institute of Technology, and Case, and the students segregated, and those who had not had any chemistry in the high school, or were shown by examination to be deficient in the subject, were required to take an extra course without credit for graduation, the courses in freshman chemistry could be reduced to five hours for two quarters, or to four hours for one year, and some time saved thereby. It hardly seems just to gauge the class and determine and set its speed and the ground to be covered by the qualifications of the least-well prepared men of the class. All students should have had the same training in freshman chemistry when they have completed their required work.

The very great variation in the times spent in lectures, recitations, laboratory practice, and in preparation in freshman chemistry, including the usual qualitative laboratory work, is best shown by the accompanying tabulation for the nineteen colleges under consideration.

FRESHMAN CHEMISTRY

	Credit Hrs.		Lectures	L. & R.	Recitation	Practice	Preparation	Total Clock Hours
	Sem.	Qr.						
U. of California	10			136		136	272	544
California Inst. Tech.		(36)	102			204	102	408
Case	(8)				102	136	204	442
Cincinnati		24			120	168	240	528
Columbia	10			90		120	180	390
Cornell	6		45		15	75	120	255
Illinois	7 or 8		34		51 or 68	102	170 or 204	357 or 408
Johns Hopkins	10				102	204	204	510
Lehigh	8				60	180	120	360
Mass. Inst. Tech.		(22)			120	90	120	330
Michigan	5		32		32	96	128	288
Minnesota		13	93		21	123	228	465
Ohio State		15	33		33	198	132	396
Penn State	6				68	102	136	306
Purdue	6			68		102	136	306
Stevens					120	160	120	400
U. of Washington		15	66		33	198	198	495
Wisconsin	8		30		30	180	120	360
Worcester	7			112		96	128	336
Average				92		140.5	171.5	393.5

DRAWING

The total amounts of time devoted to drawing at the nineteen colleges vary from 180 hours at Lehigh as a minimum (two credit hours of practice for one year, half to drawing and half to descriptive geometry), 292 at Stevens, 297 at Washington, 306 hours at California, Johns Hopkins, Pennsylvania State, and Purdue, to maxima of 433 at Case (recently decreased), 496 at Worcester, and 561 at Ohio State (now decreased to 462). The average of total clock-hours devoted to drawing is now 357, whereas in 1908 it was 420. The present tendency is towards further decreases.

Now that drawing is being taught in so many technical high schools, it is thought that there should be more acceptable knowledge of the subject offered for admission and less time should be spent on the subject in the four-year curriculum. Possibly a credit-bonus offered for knowledge and skill in the subject would put the emphasis where it belongs, and high-school boys and principals would react accordingly.

PHYSICS

The amounts of time devoted to physics vary much less among themselves than do the times devoted to mathematics and languages.

They vary from minima of 435 at Stevens, 450 at Wisconsin, 459 at Pennsylvania State, 495 at Ohio State and Washington, to maxima of 748 at California and 816 at the California Institute of Technology. The average is now 562 total hours. In 1908, it was 565 hours.

It is to be regretted that the lecture system still seems to be in the ascendancy in the teaching of physics, though not so much as in 1908. It would seem that better results could probably be obtained with students of sophomore rank if more self-expression were demanded as in the recitation. The tendency is in that direction in both physics and chemistry.

Study of the catalogs of the colleges of engineering leads one to the thought that better results could be obtained if more emphasis were put on physics applied to engineering rather than to the subject considered as a pure science.

History

It may be regretted that only five institutions (California Institute, Case, Cincinnati, Massachusetts, and Stevens) require any study of history while in college. History is now a freshman option at Pennsylvania State and Purdue. This means that if the boy did not offer high-school history for admission, it is quite possible for him to get his engineering degree without having studied anything in history except what he may have gotten in grammar school or early in his high-school course. Ohio education laws require some history to be taught in public high schools. Purdue requires 102 recitations in either a foreign language *or* in history in the first year. Stevens requires 90 recitations in general history during the first year. Massachusetts Institute requires 90 recitations in English and History, in the second year. Cincinnati requires 48 recitations on Recent United States History in its fifth year. Case requires 102 recitations on United States History during the first year. California Institute requires history for three years: General in the first year, Recent History in the second year, and United States History in the fourth year, and for all three terms of each year.

Economics and Business

Under this title are included general economics, political economy, industrial organization and management, accounting and statistics, and business law. California, Illinois, and Ohio State at present require nothing in this group for mechanical engineering students. Six quarter-credit hours in economics and three in business law will be required hereafter at Ohio State. The assignments vary from a total of 90 clock-hours for thirty recitations in

economics at Wisconsin, 165 hours at Minnesota, to 561 hours at Johns Hopkins in political economy (306) and in industrial organization and management (255 hours). Of the nineteen colleges under consideration only California Institute and Columbia at present require courses in business law. Four require courses in accounting. Ten require a course in industrial organization and management. Case requires a course in labor problems and two courses in engineering organization. The third, second, and fourth years respectively have the call for economics. Besides these colleges at which economics is required, all of them recognize it as a proper subject for election, either as a non-technical one, or otherwise. Whereas ten of these fourteen colleges gave instruction in economics in 1908, sixteen out of nineteen now do so.

Miscellany

Under this title are included civics, psychology, military and naval science, band service, hygiene, physical education, and all the non-technical electives that are listed. Only two institutions, California and Columbia, require courses in civics, and under the titles of "American Institutions" at the former, and 240 lectures on "Contemporary Civilization" at the latter. The nearest approach to a required course in psychology is an optional course in ethics in the first year at Lehigh. From this, it appears that psychology has not yet made much of an impression on the minds of mechanical engineering educators as being a greatly needed subject in the curriculum.

Hygiene is required at most colleges. To the title is sometimes added "First Aid" and sometimes "Preventive Medicine." Purdue does not require hygiene or physical education. Physical education is not required at Minnesota except when taken as a substitute for Military Science and Tactics for two years. It is required at Michigan and Wisconsin, but receives no credit toward graduation. Military Science and Tactics is not required at California Institute, Case, Columbia, Stevens, or Worcester—all private institutions; it is optional with physical education or band at Wisconsin, with the band at Purdue, or with naval science or physical education at Washington. Excessive amounts of credit as paid, advanced electives in military science are permitted at some institutions, possibly as an aftermath of the Great War. It does not seem to be logical to give more time to military science in a mechanical engineering curriculum than to chemistry, physics, drawing, mechanics or to all cultural subjects.

Non-technical electives are various and are offered in all four years at different colleges and at eleven of the nineteen colleges studied. They are sometimes listed as suggestions. Sometimes

they are specified as natural science subjects and sometimes as more strictly academic subjects. Language and history are the freshman electives at Purdue. The other colleges usually give theirs in the third year, reserving the fourth year for technical electives or options. By the use of such non-technical electives, the curriculum can be broadened out as much as may be desired and possible, even to the inclusion of the work required for an Arts degree in a five-year curriculum.

Materials

This subject in some form is taught by nine of the nineteen colleges. The minima assignments are thirty recitations and thirty hours of preparation at Massachusetts Institute, 32 hours of recitation and 48 hours of preparation at Worcester, and 99 hours at Ohio State and Washington. The maximum time is given at Johns Hopkins where a first year introductory course in materials is given, with a total time-assignment of 357 hours in classroom, laboratory, and preparation. The average for these nine colleges is now 160 total hours. In 1908 only Case, Illinois, Pennsylvania State, and Worcester gave descriptive courses in materials of engineering in their mechanical engineering curricula.

As the testing of materials is frequently taught by the department most interested, and as such laboratory courses are sometimes listed under the department of mechanical engineering, no rigid conclusions should be drawn from the figures presented by the bulletins of these nine colleges.

Mechanics

This subject has few variations in mechanical engineering curricula. It consists of statics, dynamics, strength of materials with laboratory work occasionally included, hydraulics with and without laboratory work, and advanced courses in the mechanics of machines, hydromechanics, and other special courses offered by specialists, but as electives. The amounts of time devoted to the subjects included as required courses vary from a total of 198 hours (3 lectures a week for two quarters = 66 recitations) at Washington, to 408 hours at Illinois and Johns Hopkins, 442 at Purdue, 480 at Ohio State, to 672 at Michigan (208 recitations and 48 clock-hours of practice), 688 hours at Worcester (208 recitations and 112 hours of practice), 750 hours (250 recitations) at Cincinnati, and 746 hours at California Institute (180 lectures and 171 hours of practice). The present average is 558 total hours.

Advanced courses in statics, dynamics, strength and elasticity of materials, including testing laboratory work, hydromechanics, pneumatics, aerodynamics, and other courses in advanced mathe-

matics applied to engineering machinery are now being offered as electives. Such was seldom the case in 1908. At the University of Michigan a four year curriculum in engineering mechanics is now offered. The extensions in recent years of the subjects included in this field are quite numerous and varied. It should be borne in mind that certain applications of hydraulics and all of the courses in machine design of the various kinds are usually included under and taught by the departments of mechanical engineering.

Civil Engineering Subjects

Surveying is now required in the curricula of all of the nineteen colleges, except Columbia, Illinois, Purdue, and Wisconsin. In 1908, it was required in ten of the sixteen colleges under consideration. It is now given in summer camps at Case, Lehigh, and Stevens. Masonry is given only at the California Institute. Case gave until recently one week of forty hours in the junior summer practice term to cement laboratory work. Timber and photography are no longer listed as requirements in any of the mechanical engineering curricula studied. Timber and masonry are hereafter to be included in a combined course in materials of engineering, fifty-five recitations, at Ohio State.

Structural Engineering

The theory of structures is required at Michigan, 144 total hours; roof trusses at Stevens, 219 hours; and framed structures at California, 102 hours. Ohio State required a course in trusses until 1929, since then it has been elective.

Shops

There have probably been more and larger decreases in the amounts of time devoted to shopwork than to any other subject, and to different arrangements. Now that the high schools are able to give some kind of instruction in manual training, it is thought that such elaborate instruction is not needed even for mechanical engineering students. The use and repair of motor-cars and other machinery by farmers' sons, as well as by city boys, has made less of formal training in shopwork needed in a mechanical engineering curriculum of college grade.

Another recent cause for change in the amounts of time required for shopwork is the introduction of full coöperative courses, as at Cincinnati, and courses taken in commercial shops, as at Columbia, Johns Hopkins, Case, and Ohio State where shop experience in a mechanical engineering industry is required. Columbia gives in the fourth year ninety hours of recitation and ninety hours of lab-

oratory work to courses in "Shop Processes" and follows this with eight weeks in summer, or 352 hours of "Shop Practice" in "commercial shops in planning work, use of tools, and in the handling of men, etc." Johns Hopkins requires that three summers, or 1,144 hours, be given to "Industrial Work." At Ohio State and Pennsylvania State, the regular laboratory courses in shopwork are supplemented by required courses in commercial shops in the industry. These practice courses in a mechanical engineering industry are required for ten weeks, or 440 hours, at Ohio State, and for 18 weeks, or 792 hours, at Pennsylvania State. No shopwork is required to be done while in college, except in the mechanical engineering laboratory and that incidentally, either at the University of California or at the California Institute of Technology. The 153 hours of laboratory shopwork required at Case is supplemented by 2½ weeks, or 97 hours, spent in inspection trips, excursions, and shop practice in the sophomore summer practice term. Even Worcester Polytechnic Institute, which once gave more time (1,260 hours of practice in 1908) to shopwork than did any other college, now requires only 648 hours total time devoted to its several shop courses. It is estimated that 5,500 hours are normally spent by the coöperative student at the University of Cincinnati in practical experience, but it must be remembered that much of this time is spent in earning an income, and for the purpose of acquiring skill as well as knowledge, and not in the most logical presentation of the industrial processes. Of the remaining ten colleges, the minima are 165 total hours devoted to shopwork at Washington and 175 hours at Stevens; and the maxima are 450 at Wisconsin, 480 at Michigan, and 648 at Worcester. The average clock-hours devoted to lecture, recitation, practice, and preparation in shopwork is now 345. In 1908 it was 551, of which 493 was in practice.

The content of the shopwork courses has changed greatly since 1908, and is continuing to change. The best proof of this can be seen at the new Shops Laboratory at the Massachusetts Institute of Technology as compared with their shops in 1908 and their shops in the basement of the old Rogers Building fifty years ago.

Electrical Engineering

The amounts of time devoted to electrical engineering subjects vary from a high maximum of 918 at Johns Hopkins, with Cincinnati second requiring 570 hours, to minima of 208 and 210 at Michigan and Massachusetts and 264 at Ohio State. The average of the nineteen is 402 hours total time. In 1908, the average time devoted to electrical engineering subjects was 87 hours spent in lec-

tures and recitations and 115 hours spent in laboratory practice, or a total of 376 clock-hours. While the present assignment of 402 clock-hours is a slight gain over that of 1908, it is thought that still more time could well be devoted by mechanical engineering students to the theory and practice of the applications of electrical engineering.

Engineering Practice

It is difficult to differentiate between professional engineering practice and the shop-practice courses given at certain colleges. Cincinnati requires that 240 hours (80 recitations) be devoted to "Engineering Practice" and Wisconsin calls for six weeks of summer engineering practice, or for 264 hours. No credit is assigned to such work under this name at the other colleges.

Inspection Trips

In 1908, of the nineteen colleges under consideration, only Case, Lehigh, Ohio State, Purdue, and Stevens required inspection trips; now four other colleges devote time to out-of-town trips. Illinois during the Autumn semester spends 24 hours on such trips; Purdue, 40 hours; Wisconsin, 44 hours; and Ohio State, 44 hours each in the Spring quarters of the third and fourth years. Tours of inspection are taken by junior and senior students at Pennsylvania State at a total expense which should not exceed $80. The senior trip is one week long and comes in the second semester. Cincinnati gives one unit of credit throughout the pre-junior year for power-plant inspection trips, 48 hours. At Case, 97 hours are spent in visits to local shops and engineering establishments and two weeks (80 hours) are spent in visiting out-of-town industries during the junior summer practice term, at an expense of from $100 to $125. The other ten colleges apparently give no time to such work. The arguments for inspection trips for students are numerous and have been published in the *Proceedings* of the Society. The arguments against them are their cost to students and college, the labor required in planning them, the inconvenience caused other departments if they are taken in term-time, and the time involved.

Thesis

A thesis was once required from every graduate and his ability to prepare and write a satisfactory one was his final examination for his degree. With the increase in the numbers of students in the graduating class, and the demand for more and more elaborate equipments, and the costs thereof, experimental theses have become less popular among the members of the faculty of mechanical engi-

neering departments. Design theses have never been popular. Many of the theses of forty years ago consisted of so-called "Reviews" of things already accomplished and were seldom original or additive to human and professional knowledge. Theses are now required at only six of the colleges studied. The amounts of time vary from 99 total hours at Washington, 102 at Purdue, 105 at Massachusetts, 192 at Cincinnati and Worcester, 204 at California (or seminar), and a maximum of about 250 hours at Case. At the other colleges, theses are elective. At Michigan, it is included among 432 hours of "other fourth-year electives."

Mechanical Engineering

To get a proper view of the mechanical engineering subjects which are taught and of the times devoted to them in the colleges under consideration, the times devoted to mechanical engineering laboratory work should be included, as, not at all infrequently, laboratory work is included in the bulletin under practice hours of a book-course, such as steam engines and the like, as is the accepted practice with chemistry and physics.

It is well understood that there are only from six to eight thousand hours available for study and classroom and laboratory work in four years each of eight to nine months, each of four weeks, and each of from forty to sixty hours, and that, if the faculty thinks that cultural and general subjects are of more importance than professional subjects in an engineering curriculum, there must be a corresponding deficiency of engineering subjects and hours as compared with the curricula of those colleges where much stress is laid on professional work. Some colleges have extensive and well-equipped laboratories and devote much time to laboratory work and instruction; while others use the institution's power plant as a laboratory, and go off the campus for even simple tests, or borrow the use of machinery and apparatus when they are able to do so. Some colleges seem to demand and get more work from their students than do others. One college is reported to schedule all of a student's time from eight until five o'clock or for 44 hours per week as a daylight-starter. Others are more merciful and less paternalistic. It makes a difference whether the semester has seventeen net teaching weeks, or only fifteen, and whether two weeks, rather than four days, are spent in final examinations. It is for these reasons that the net times devoted to mechanical engineering subjects including laboratory work vary so greatly in these nineteen colleges.

Recitations in mechanical engineering subjects, including electives, vary now from 176 hours at Worcester and 204 at California Institute to 638 at Ohio State and 680 hours at Pennsylvania State, and average 466 hours of recitations or lectures. In 1908 the

average of the 26 colleges was 354 recitations. This is a gain in recitations of over 31 per cent, since 1908. The times spent in the drawing room, in laboratory, and in note-writing now vary from 372 hours at Cincinnati, not counting their coöperative work in outside shops, 377 at Stevens, 421 at California Institute, and 435 at Massachusetts Institute, to 884 at Worcester, and 939 at Cornell, and 1,653 at Columbia in its six-year curriculum. Practice time has remained about the same since 1908 and averaged 628 hours in the laboratory and drawing room in 1908 and 638 now. The total times expected of the student in lecture, recitation, laboratory, drawing room, and preparation for mechanical engineering subjects vary from 945 at California Institute, 1,023 at Stevens to 2,703 at Pennsylvania State and 3,405 hours in six years at Columbia. The averages have changed from 1,689 in 1908 to 2,025 in 1933, or an increase of 20 per cent.

Referring to the mechanical engineering subjects, only seven colleges have a course in "kinematics" under that title, but all except Purdue have one or more courses in kinematics or mechanism. At Purdue, it is included in machine design. They are given in either the second or third year, and occasionally in the fourth year. Washington requires 38 and Wisconsin 60 hours of recitation and no practice work. All the others require practice work.

The times devoted to machine design vary greatly. California, Washington, and Worcester require only practice in machine design, but vary from 102 to 363 hours to 224, respectively. Cincinnati requires no practice but has 136 recitations. Columbia, in its six-year curriculum, has 90 hours of recitations and 491 hours of practice. Massachusetts gives 90 hours each to lectures, recitations, and practice. Ohio State has 118 recitations and requires 126 hours of practice. Case has 102 recitations, and only 51 hours of practice, but it has an elective course in machine design. Stevens gives 45 recitations and 115 hours to practice in machine design. In 1908, an average of 702 total clock-hours was spent on mechanism and machine design; 117 lectures and recitations and 350 hours of practice. Now, on the average, 133 hours are given to lectures and recitations and only 251 hours to practice, or a total of 651 clock-hours. This is a very decided drop in practice work and conforms to the unwillingness of graduates to go into the drawing room of even a large corporation.

Orientation and Introductory Courses

These are given, in one form or another, at ten of the nineteen colleges and vary from twelve lectures at Stevens to 33 lectures on a Survey of Engineering and 44 lectures in the second year on an Introduction to Mechanical Engineering at Ohio State.

Heat Engines

Courses in heat engines, steam boilers, engines, and power plants, and thermodynamics still form the backbone of most mechanical engineering curricula, with machine design as their closest competitor. They vary from a minimum of 96 recitations and 128 hours of laboratory practice at Worcester to 204 lectures at the University of California. Courses in steam turbines are required at Columbia, Johns Hopkins, Lehigh, and Pennsylvania State and are elective at several of the other colleges. The time spent varies from 30 to 68 recitations. Courses in internal combustion engines are required at eight of the nineteen colleges and vary from 30 to 72 recitations. Other colleges offer elective courses, either in gas and oil engines or in automotive and aeroplane engines, or both. At some institutions, these subjects are given some attention under the general courses in heat engines and thermodynamics. Compressors and fans is a required subject only at Columbia. Refrigeration is required at Pennsylvania State, is a technical option at Illinois, Massachusetts, and Purdue, and is an elective at several colleges.

General Mechanical Engineering Subjects

A course in locomotives is required at Pennsylvania State. Courses in railway mechanical engineering are elective at Pennsylvania State and Purdue. Illinois has a School of Railway Engineering and Administration with five curricula, one being in railway mechanical engineering. Pennsylvania State has a curriculum in railway mechanical engineering and offers seven courses in that field. The small demand for such courses and the attitude of the railroads has not tempted other colleges to offer them, as was the expectation in 1908. Classroom and laboratory courses in hydraulics and hydraulic machinery are required at eleven of the colleges under consideration and are elective at most of the others. Elective courses in aeronautical engineering are offered to mechanical engineering students at several of the colleges, but only at Cincinnati is a course (36 recitations) in the Elements of Aerodynamics required. Four-year curricula in aeronautical engineering are offered at Massachusetts (41 courses), Michigan (19 courses), and Washington (22 courses); five- and six-year curricula (14 courses) are offered at California Institute. The courses which are offered on such subjects as contracts, business law, time- and motion-study, production-design and -methods, industrial relations, organization, and management, specifications, safety, and the like, vary greatly at different institutions both in content and time allotment, and are included in curricula in industrial engineering; whereas courses in accounting, cost account-

SUMMATION OF TOTAL CLOCK-HOURS EXPECTED OF STUDENTS IN A FOUR-YEAR CURRICULUM IN MECHANICAL ENGINEERING AT NINETEEN OF THE LEADING ENGINEERING COLLEGES OF THE U. S. A., 1932-33

	Lectures	Recitations	Lects. & Rec'ns	Practice	Prepa-ration	Totals
California, Univ. of			1,804	1,734	3,608	7,146
California Inst. Tech.			2,104	1,900	3,278	7,282
Case School of Applied Science			2,064	2,451	4,012	8,527
				(5,500)*		(5,500)*
Cincinnati, Univ. of (five years)			2,130	1,566	4,216	7,912
				(352)*		(352)*
Columbia Univ. (six years)			1,995	2,358	3,990	8 343
Cornell Univ.	435	963	1,398	1,994	2,876	6,268
Illinois, Univ. of	442	1,275	1,717	2,193	3,366	7,276
				(1,144)*		(1,144)*
Johns Hopkins Univ.	34	1,921	1,955	2,176	3,910	8,041
Lehigh Univ.	135	1,554	1,689	2,319	3,258	7,266
Massachusetts Inst. Tech.			1,920	1,485	2,610	6,015
Michigan, Univ. of	332	1,488	1,820	1,600	3,632	7,052
Minnesota, Univ. of	452	1,210	1,662	1,766	3,386	6,814
				(440)*		(440)*
Ohio State Univ.	394	1,524	1,918	1,907	3,943	7,768
				(792)*		(792)*
Pennsylvania State Coll.	102	1,802	1,904	2,152	3,808	7,864
Purdue Univ.			1,887	2,142	3,774	7,803
Stevens Inst. Tech.			1,976	2,082	1,976	6,034
Washington, Univ. of	132	1,320	1,452	1,914	3,035	6,401
Wisconsin, Univ. of	120	1,440	1,560	2,424	3,120	7,104
Worcester Polytechnic Inst.			1,664	2,684	3,008	7,356
Averages			1,822	2,044	3,411	7,277

* Superimposed numbers in parentheses are for required hours spent in industry. They are not included in the averages.

SUMMARY OF TOTAL CLOCK-HOURS OF LECTURES, RECITATIONS, PRACTICE, AND PREPARATION EXPECTED OF STUDENTS AT NINETEEN OF THE LEADING ENGINEERING COLLEGES OF THE UNITED STATES IN MECHANICAL ENGINEERING, 1931, 1932, 1933.

	Cal.	C.I.T.	Case	Cin.	Cola.	Corn.	Ill.	J.H.U.	Leh.	M.I.T.	Mich.	Minn.	U.S.U.	Pa. St.	Purd.	Stev.	Wash.	Wis.	Worc.	Aver.
Lang.	108	476	696	474	270		714	408	540	420	480	369	396	510	918	239	198	270	928	467.4
Math.	816	816	918	774	540	450	918	918	675	540	768	780	990	816	918	510	693	810	928	767.2
Drwg.	306	309	433	366	270	397	408	306	180	420	384	345	561	306	306	292	297	405	496	357
Chem.	544	529	892	576	615	345	561	510	585	420	336	597	528	408	306	670	495	450	336	510.6
Phys.	748	816	595	504	675	508	510	612	540	630	544	554	495	459	510	435	495	450	592	561.6
Hist.		442	306	144												180				268
Ec.		312	558	432	180	442		561	270	270	288	165		306	357	264	231	90	480	325.3
Misc.	1,190	1,048	238	364	945	270	816	544	780	450	352	816	495	986	952	717	825	315	160	645
Mech.	612	746	595	750	630	495	408	408	495	555	672	665	480	510	442	581	198	585	688	558
Matl.		229		144		180		357		60	192		99				99		80	160.0
C.E.	153	264	216	72		121		153	224	60	112	110	198	51		234	99		64	142.0
Stru.	102										144					219				155.0
Sum. Prac. Shop			153	216	315	351	459	-0-	352	285	480	417	495	255	306	175	165	450	648	345.1
					(352)			(1,144)					(440)	(792)						(682)
E.E.	374	276	374	570	495	420	408	918	405	210	208	248	264	408	374	451	396	450	384	401.7
M.E.	1,581	813	1,875	1,806	3,003	1,926	1,734	2,040	1,815	1,380	1,328	1,459	2,106	2,295	2,074	893	1,715	2,250	992	1,741.3
M.E. Lab.	408	132	193	240	405	318	306	204	270	210	288	186	477	408	204	130	396	225	388	283.5
Insp.			177	48			(24)		(√)				88	44	(40)	44		(44)		64
Eng.P.				240																(36)
Thesis	(204)		250	192					(135)	105	(432)				102		99	264	192	252.0
																				157
Other		74	58	(5,500)		45	34	102			44	103	96	102	34					(190.2)
																				69
Total	7,146	7,282	8,527	7,912	8,343	6,268	7,276	8,041	7,266	6,015	7,052	6,814	7,768	7,864	7,803	6,034	6,401	7,104	7,356	(5,500)
Prac.				5,500	352			1,144					440	792						7,277.4
G. Tot.	7,146	7,282	8,527	13,412	8,695	6,268	7,276	9,185	7,266	6,015	7,052	6,814	8,208	8,656	7,803	6,034	6,401	7,104	7,356	1,645.6
																				7,710.1

The numbers in parentheses under "shops" are for hours required to be spent in Summer practice in industry.
The numbers in parentheses opposite "thesis" are for technical electives, including thesis.

ing, business management, economic organization, business law and statistics, corporation finances, investments, money and banking, and the like are included in curricula in administration engineering at Cornell and Massachusetts.

Electives and Options

In 1908 a few electives, 2 to 12 credit hours, were offered at eight of the 26 colleges considered. Now, non-technical elective courses are offered at several of the colleges; technical electives are offered in the fourth year of the curriculum, and sometimes also in the third year, at almost all of the colleges; technical options, or groups of kindred technical courses, are offered in the fourth year, seven at Purdue, six at Cornell, five at Illinois, four at Massachusetts; and, when a curriculum gets top heavy with many technical electives and options in its fourth year, it is separated from its parent and caused to stand on its own feet. This has been the history of the establishment of degree-giving curricula in electrical engineering forty years ago, and of aeronautical, administrative, business, gas, general, industrial, and railway engineering and in engineering mechanics since 1908.

Summation of Hours

From the accompanying summation of the total clock-hours of time expected of mechanical engineering students in each of the nineteen colleges under consideration, it will be seen that the numbers of lectures and recitations vary from maxima of 2,130 at Cincinnati, 2,104 at California Institute, and 2,064 at Case, to minima of 1,398 at Cornell and 1,452 at the University of Washington, and average 1,822 lectures and recitations during the four years, including the five-year coöperative curriculum at Cincinnati and the six-year curriculum at Columbia. Similarly, the hours of practice vary from maxima of 2,684 at Worcester, 2,451 at Case, and 2,424 at Wisconsin to minima of 1,485 at Massachusetts Institute, 1,566 at Cincinnati, and 1,600 at Michigan, and average 2,044 clock-hours of scheduled laboratory or practice work, exclusive of required practice work in industry. While the hours of preparation at several colleges are very definitely specified (Case, Massachusetts, Ohio State), it is debatable as to whether the students actually put in the expected number of hours on their work, on the average. At times, it will probably be below and at others it will be in excess and not infrequently greatly in excess, or the opposite. The figures given for the expected hours of preparation are the results of much careful study of the facts, and as checked

by the representative of the college concerned. They vary from maxima of 4,216 for Cincinnati, 4,012 for Case, and 3,943 for Ohio State to minima of 1,976 for Stevens, 2,610 for Massachusetts Institute, and 2,876 for Cornell, and average 3,411 clock-hours devoted to preparation for classroom and laboratory work. The grand totals for the four years vary from maxima of 8,527 for Case, 8,041 for Johns Hopkins, and 7,912 for Cincinnati, not including the times spent off the campus in industry, to minima of 6,015 at Massachusetts Institute, 6,034 at Stevens, and 6,268 at Cornell, and averaging 7,277 total clock-hours of time devoted to the obtainment of a first degree in engineering exclusive of the examination periods.

In 1908, the averages for the 26 colleges then under consideration were 1,635 lectures and recitations, 2,091 hours of practice, and 3,270 for preparation, or a total of 6,996 hours. By comparison, it will be apparent that some colleges have increased their demands upon the time of the students since 1908. This has usually been done by adding one or two supplementary terms in the summer. The great diversity of times devoted to lecture, to recitation, to practice hours, and to preparation should lead some faculties, as it is beginning to do, to inquire if their curricula are too heavily, or possibly too lightly, loaded with classroom or laboratory work, or both, and if some modifications would not be wise. This is a subject on which educators and faculties may be expected to differ.

When it is appreciated that of a college's graduates in mechanical engineering less than half go into power-plant work, railroads, the automotive, aeronautical, marine, oil refining, miscellaneous and other fields, and that from fifty to fifty-five per cent go into manufacture and sales, the question arises if the colleges are doing right by themselves and their mechanical engineering students by not offering, even if not requiring, more courses in economics, business-law and -management, industrial- and production-control and -planning, motion- and time-study, jig and tool design, engineering mathematics beginning with arithmetic, cost accounting, the making and use of graphs, mental philosophy now popularly known as psychology, sociology and the mutual duties of the employer and his workers, labor, its turnover and its rewards, and many other subjects which were not known or even thought about in 1908, except by the few. The mechanical engineering curricula of the future will require many of these subjects and as then demanded by industry and the students. The production-control engineer of the future will be called upon not only to control the details of an industry but of the industries and of our national life considered as an industry. The problems are

theoretically the same; they differ only in size and importance and therefore in difficulty.

While the mechanical engineering curricula have not stayed fixed during the last twenty-five years, they have been kept awake by the activities of the national society, the A. S. M. E., on the one hand and by competition with other curricula, notably those in industrial, aeronautical, and administrative engineering. The world and industry seem to need the services of men who have had these kinds of training, but the curricula should be equal in quality, intensity, and time required and differ only in their contents.

It does not follow that because the American Society of Mechanical Engineers has sixteen professional divisions—aeronautic, applied mechanics, fuels, hydraulic, iron and steel, machine-shop practice, management, materials handling, national defense, oil- and gas-power, petroleum, power, printing, railroad, textile, and wood industries—that therefore every college should redesign its mechanical engineering curriculum so as to prepare its graduates for just some one of these divisions. While it is probably true that about sixty per cent of the membership of any one of the large national engineering societies are engaged in managerial work, it does not follow that courses in management should form the backbone of an engineering curriculum. It is well to know something about what one is expecting to manage before getting too deeply into the laws which govern its management. However, it behooves the mechanical engineering faculties of our colleges to note the trends being followed by other curricula and colleges, and by the national parent societies.

The mechanical engineering curriculum of the future will be a three- or four-stage affair. It will take in from the high school large numbers of students who have been told that they have "completed" their secondary school education, and will put them through a carding machine to adjust their mental concepts and get them oriented. It will try to give these young people an education which will fit them first for citizenship in a democracy; second, an ability to enjoy nature, the world, other people, and themselves without becoming bored, and in a world full of machinery and operated on the 30- or 40-hour week and in which they will have a surplus of leisure and of time in which they may enjoy themselves, be doing good to others, and live a happy life; third, facilities with which to complete some definite bit of training which will be helpful in earning a living; and lastly, on its satisfactory completion will give them a certificate which will state what the possessor has accomplished. Such a cycle will probably take two years to complete. Those who do will have much satisfaction as citizens and artisans. Some of them should have become ambitious

enough to proceed further, if their natural aptitudes will warrant it, and become technically trained men and engineers while being further compressed in the second stage of the educational machine. This cycle will probably also take two years to complete, and those who do should receive a diploma and a degree, as the American youth insists on receiving some form of document and handle to his name after four years of study. Industry can use much low-pressure compressed-air and many artisans who have had two years of general training. It will continue to use men who have had a more technical education, and who will be capable of filling positions as engineering salesmen, foremen, designers, and eventually of becoming superintendents and managers. Some of the men can be compressed further and intensified by a year or two of graduate study and should receive a master's degree in mechanical engineering. A very, very small portion of the human material which entered the first stage of education from the high school will be needed or capable of proceeding still further so as to make themselves proficient in experimentation and research work, design and invention, economics and management, and earn the degree of doctor of engineering. The mechanical engineering curriculum of the future must be designed so as to adequately supply to industry and the world at each of the stopping points such numbers of suitably trained units as will then be needed and can be readily absorbed. Just at present the problem before most faculties and trustees is what is best to be done in the present emergency.

CONFERENCE OF ADMINISTRATIVE OFFICERS OF ENGINEERING COLLEGES

The articles which follow on pages 117 to 175 of the present issue of the JOURNAL are selected from among those presented at the Conference of Administrative Officers, called by the Board of Investigation and Coördination and held at the University of Wisconsin, July 3 to 7, 1933. A general description and summary of the Conference, its purposes and results, will be found in the September, 1933, issue of the JOURNAL.

OPENING OF THE CONFERENCE

By CHARLES F. SCOTT,
Professor of Electrical Engineering Emeritus, Yale University

Chairman, Board of Investigation and Coördination, Society for the Promotion of Engineering Education

The story of engineering education reveals a coincidence between its various chapters and our economic depressions.

The Morrill Act proclaiming agriculture and the mechanic arts was passed in the distressing Civil War period.

The panic of 1873 characterized a decade in which our engineering schools increased from a score to more than four-score.

During the depression of the early '90's the Society for the Promotion of Engineering Education was organized, inaugurating a new type of professional society.

In 1907, a year of acute depression, the society enlisted the national engineering societies in a survey, later aided by the Carnegie Foundation and culminating in the Mann Report.

In the depression of 1921–22, the society's Development Committee proposed that a Board of Investigation and Coördination take constructive steps to develop, broaden and enrich engineering education.

It did investigate and coördinate; and its normal activities terminated when its director became a college president on September 1, 1929. Forthwith there began a tail spin from the dizzy heights of prosperity attained during the active years of our investigation. And just now we are trying to gain equilibrium and acceleration for the upturn of the cycle.

A constructive adventure is apt to lead to unexpected by-products. From the statistical diagnosis made in our investigation came the deduction that better schools are made by better teachers,

and so we set about the improvement of teachers by summer schools. The twelfth session, beginning in Madison this week, completes the three-week conferences in the principal fields of instruction of engineers which have brought together a thousand teachers and members of staff. Professor Hammond, Director of Summer Schools, has visioned the methods of the summer school in dealing with matters of instruction applied to problems of administration, and now, after many consultations and much planning, the Summer Conference of Administrative Officers is this moment crystallizing into reality.

In the early days of our investigation some faculties paused in their picture-puzzle game of readjusting curricula to await the Board's formula prescribing the proper hours for drawing and applied mechanics and economics. But they were disappointed; the Board presented facts as to existing situations and it proposed objectives; it dealt with principles and with quality rather than quantity. This, in general, has been the policy underlying the growth and strength of our Society. It is strong on presentation and discussion and its committees make recommendations, but final policies and decisions lie with individual institutions. Likewise the Summer Schools have not indulged in the making of rules and resolutions, but the presentation of experts has been followed by discussion in formal sessions and in informal groups, trusting for results to interest and information and inspiration.

And it is now proposed that the same principles may be serviceable in this conference. A critic has suggested that in a group of this kind it would be difficult to get real expressions of opinion as there is strong tendency toward generalities. And furthermore, that some of the acute problems which disturb administrators are not of a kind that they care to expose to large groups. It is hoped that the round table discussions may be intimate and fruitful. Possibly however some of the richest returns will come from informal evening groups or in walks and talks by the wayside.

When we were planning this conference, the engineering vice president of one of our leading industries expressed the fear that constructive long range planning might be forced to the background by the emergency problems of present transient disturbances. To this perspective view from a detached vantage point we may well give heed. The story of engineering education in the past like the biographical sketch of most engineers has been one of readjustment to the changing environment of a changing civilization. The lamp of experience indicates no clear, smooth road in the future. Fortunate are we if we can discover its general trend and prepare our engineering graduates to go that way and to decide intelligently when the road forks. Some observant deans

have noted that their depression year classes contain the largest proportion of eminent graduates. Industry uses depressions for essential readjustments. Adversity has its compensations.

In scanning the program for the coming week, you may note that it opens with several sessions which present the concrete facts and conditions of our present situation. This may be the basis for consideration of more fundamental issues and their conclusions. It may also be observed that the special committee of mere professors in charge of the program has not prescribed too rigidly just what deans and presidents should talk about. The program is flexible; there is much unassigned time; in fact this conference will be in large measure what the members care to make it. We searched long before deciding upon time and place; it is gratifying to note an attendance of over 70,* and it is a pleasant relief to escape from the torrid pandemonium of Chicago to this delightful spot where the beauties of nature are supplemented by the cordial hospitality of our hosts.

If President Glenn Frank were able to be here, he might perchance address us as he did his recent newspaper audience:

"We are at a dangerous moment.

"We shall pay for it if we give up our faith in the engineering mind."

And today, administrators of engineering schools—men of the engineering mind—have assembled to apply that engineering mind to their own problem, that of supplying facilities and policies with which the productive agencies of engineering colleges—the faculties and students—may function to produce engineers for the coming decades.

* The total enrolment during the conference was 95. Attendance was by invitation, extended to administrative officers of all the engineering schools of the country and to the officers and members of the Council of the Society. The attendance comprised 6 presidents, 52 deans, 30 heads of engineering departments and 7 other individuals, representing 33 states and 64 colleges and universities as well as 6 other organizations.

WHAT IS HAPPENING IN ENGINEERING EDUCATION? *

By H. S. ROGERS,†

Dean, Oregon State Agricultural College

The first morning of the Conference of Administrative Officers at Madison, after the opening remarks by Charles F. Scott, was devoted to a symposium on "What is Happening in Engineering Education," in which H. S. Rogers represented the Pacific Coast, H. S. Evans the Rocky Mountain region, Willard E. Hotchkiss the Midwest, B. R. Van Leer the South, and R. L. Sackett the Atlantic Coast. The topic was discussed from two viewpoints; one, that of the long time epochal changes of values and policies in engineering education which have been controlled by the status of scientific knowledge, the needs of industry, and the importance of individual welfare; and the other, that of the cyclical changes caused by the present economic conditions and affecting more directly and more particularly the organization, procedures, and administration of engineering schools. The greater emphasis throughout the symposium was, however, placed upon the immediate problems created by the cyclical economic conditions.

Conditions and needs surrounding the epochal trends were discussed by Dean Sackett who emphasized the significance and merit of educational "practice developed over a long period of gradual evolution." He commented upon the common "suggestions that engineering curricula should contain more cultural subjects, though culture is as indefinite in the minds of the proponents as fabled Atlantis." He advanced the thought that standards of culture may have changed, and "That engineering in this age may be cultural seems never to have entered the minds of those who are ignorant of its significant contributions to this civilization." He advocated a broader view in instruction in the engineering fields which heretofore have been mainly concerned with "productive enterprise and financial contributions to the welfare of society" and further proposed the additional objectives of "security and service" to meet changing conditions and place "an

* Digest of a Symposium held at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 3, 1933.

† Since August, 1933, *President*, Polytechnic Institute of Brooklyn.

emphasis on the cultural aspects of engineering." "The practical has dominated the picture to the exclusion of the ethical," yet "Out of this confusing period should come an increased appreciation of the social contributions engineering has made" and "an emphasis upon its services in promoting human welfare." He advised that the basic sciences and mathematics, and engineering subjects as well, be presented also in their social settings. He described the passing of the nomad and pioneer engineer and the present need for participation in governmental and civic affairs. He also advocated study at the graduate level of "our industrial history and its influence on our economic life" as well as study "in the field of industrial economy and finance" to the end that "graduate students should have a better understanding of safe, sane, economic policies which sound institutions must pursue."

Dean Rogers elso emphasized some of the problems resulting from the epochal movements in industry, public economy, and education with particular stress upon the need for a broad philosophy of engineering education which would be generally accepted by engineering educators and would have the sanctions of the Society. This latter characteristic would lend a deal of weight in its application to the reorganization of higher education undertaken in various states. He emphasized the fact that engineers must take a larger responsibility in such reorganizations and must be able to give a clearly defined picture of the aims and values of engineering education. He also accented the need for coöperation with industry in the development of leadership founded upon a constructive and objective philosophy of industrial and public economy.

The curriculum changes suggested by needs of the epochal movements in industry, education, and society are in part also desirable because of the cyclical movements in industrial and public economy. The cyclical trends in business and public finance have, however, exerted a more powerful and immediate influence on changes in general institutional organization, in basic educational factors, and in coördinate and collateral functions. These changes as indicated by the speakers are of a varied nature depending upon the urban or rural location, as well as upon the public and institutional finance surrounding or controlling each college. The larger portion of the discussion was directed toward these immediate changes.

From the Northwest it was reported that all or some of the institutions in Oregon, Montana, and Washington had undertaken some reorganization, and from the South it was also reported that state supported institutions in Georgia and North Carolina were in the process of reorganization. A number of state schools in the South and a few in the North Central area have also found it

necessary to reorganize curricula and departments. In practically all cases the motivating forces for these reorganizations have been economy and better coördination, which have brought about consolidations and eliminations.

Among the changes in basic educational factors discussed were admissions, enrollments, curricula adjustments, faculty adjustments, teaching loads, physical facilities and budgets. Dean Evans reported a shortening of the high school year in Colorado which may become serious if continued and may eventually cause the requirement of an extra year in high school for preparation to enter the university. Dean Van Leer discussed the same problem in the South where "most of the southern institutions will be compelled this next year to admit high school graduates who have had in the last year of their high school work only seven or eight month's schooling." These changes will, undoubtedly, result in an increased need for a qualifying examination which Florida has already adopted for those seeking admittance. For the Atlantic States, Dean Sackett emphasized the need for improvement in the methods of selecting freshman, and the importance "that steps be taken which will assist the engineering colleges in drawing to their ranks those students who are best prepared to succeed."

The fluctuations in enrollment gave a confusing and varied picture. The freshman classes have decreased from zero to fifty per cent in some institutions while, on the other hand, in a very few they have increased. Dean Van Leer reported an increase in total attendance in the six schools in the South. Dean Evans reported a decrease in the freshman class of about twenty-nine per cent and a decrease of about fourteen per cent in the total. Dean Rogers reported variations in total enrollment from an increase to a decrease of approximately thirty per cent, and in freshman enrollment a decrease of as large an amount as fifty per cent.

Curricula adjustments of a conservative nature as a result of both epochal and cyclical changes were reported or suggested by all speakers. Dean Evans reported a shift of students from engineering to business administration as a result of changing objectives under the present economic conditions, and considered the advisability of a combined program possibly covering five years in which the essentials of both courses might be included. Dean Rogers told of the business and commercial options or curricula in most of the Northwest schools. Dean Sackett emphasized the need and increasing importance of a better understanding of the basic principles of trade and finance which might be obtained through a graduate minor "in the fields of industrial economy and finance." Dean Van Leer told of the organization of a curriculum in industrial engineering "without adding a single new course to the

curricula" of the University of Florida. President Hotchkiss told of an interesting introductory and orientation course in the freshman year in which problems of business, economics, and sociology are integrated with engineering problems, and of the introduction of new courses in business and public policies in the senior year particularly adapted to engineering needs in lieu of required courses in formal economics.

Faculty adjustments were discussed by only two of the scheduled leaders, but were considered by several of those who spoke from the floor. The problems of localizing the burden where decreased enrollments have occurred, of sharing the work as a means of distributing moneys available and protecting faculty welfare, and of reaching permanent readjustments were briefly treated. It was, of course, emphasized that faculty readjustments should be made with full consideration of the paramount interests of the student welfare and institutional strength.

The tendency to increase teaching loads was indicated by President Hotchkiss and Deans Van Leer and Rogers. While such increases have been minor in the North, it seems that in the South they have been extremely heavy and regretable in many institutions.

The discussion of budgets brought forth the common practice throughout the country of eliminating first capital investments, of cutting maintenance and supplies heavily, and of reducing salaries last. Reductions reported ranged from nothing in a few instances to a general group between ten to twenty-five per cent. The discussion of this topic left the impression that in all but a few severe and localized cases there has been no serious impairment in the educational service to the youth of the country as a result of these reductions.

A problem more serious than this for the welfare of youth as a whole was emphasized by Deans Evans and Sackett in the discussion of student finances. The former related how many students found it necessary to put too much time on outside work in order to earn the necessary expenses, and how others had "tried to get along with insufficient food and had consequently suffered" in accomplishments and health. The latter emphasized the importance of guiding students so that they may undertake tasks from which they may obtain value received, and advocated that institutions should not accept students who are not in a position to profit from the opportunity offered.

Research programs seem to have been laboring under financial retrenchments and yet simultaneously to be needed and stimulated by increased graduate enrolments. Dean Evans, while realizing these increased enrolments were due in large part to the inability

of new graduates to find jobs, thought they were also due "to a growing realization of the value of formal education beyond that of the degree." President Hotchkiss told of leaving "sufficient margin to enlarge considerably the scope of graduate work" while simultaneously reducing budgets and adjusting teaching loads with the anticipation that such a program would advance the undertaking of graduate study. Dean Rogers reported an increasing number of graduate enrolments which was, however, limited by restricted student finances.

Some very brief discussion was given to extension short courses and institutes, personnel programs, and the responsibility for staff development. In the West there is a particular demand for short courses in Mining which has been stimulated by unemployment and the opportunity to earn a small grub stake in placer areas. In the East there is both a demand and need for evening and special courses adapted to the needs of unemployed technical men.

The policies and procedures to be followed in the administration of engineering education in the face of these needs and conditions were, of course, discussed formally and informally throughout the remainder of the conference. There was no effort, however, to discuss or determine a general formula or standard procedures, because it was generally recognized that such wide variations existed as to make this impractical and unwise. Perhaps the greatest advantage arising from this introductory symposium and following discussion from the floor resulted from the description of conditions throughout the country which enabled those with similar problems and interests to identify each other and to meet in informal and friendly ways for the discussion of these problems throughout the entire conference.

THE FINANCIAL OUTLOOK FOR HIGHER EDUCATION IN THE NEXT DECADE *

By CHARLES R. MANN,

Director, American Council on Education

Prophesying the financial outlook in business is no longer such a favorite pastime as it was; and since the outlook for education is dependent on the outlook for business, it is doubly dangerous to prophesy the financial outlook for education.

Most of our confusion about education arises from loose use of the word *education*. Agreement on the meaning of this word will give us a base to which we can refer in judging the financial outlook. The best definition of education is one given by John Dewey: "Getting from the present the degree and quality of growth there is in it is education." Education thus is an individual process of growth that goes on inside of each individual. On the basis of that definition the subject of this discussion is not the financial outlook for higher education, but the financial outlook for higher educational institutions.

As the first proposition in this discussion I suggest that the financial outlook for higher educational institutions depends on how keenly people recognize that higher schooling helps them get from the present a larger degree and a finer quality of growth.

The extent to which the American public already recognizes higher educational institutions in this regard is shown first by the number of students who take advantage of the higher educational institutions. In England only one out of 1700 of the population of college age attends an institution of higher education. In Canada and the Provinces only one out of every 700 attends an institution of higher education. In the United States one in seven of the population of college age attends an institution of higher education. This fact shows that people recognize the value of higher education. This number increased rapidly after the war because then the public learned that if a man wanted to become a commissioned officer he had to have a college education.

The cost of supplying these facilities of higher education in 1929, when the national income was about 90 billion dollars, was about 450 million dollars, or only one-half of 1 per cent of our

* An address delivered at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 3, 1933.

national income. Now, when the national income has shrunk to about half its former size, this expenditure for higher educational institutions (unless cut), would be about 1 per cent. The fact that it was cut seems to show me that the public estimates the value of higher educational institutions at less than 1 per cent of the national income. This fact is not so discouraging if we might feel assured that when the depression is over school budgets would be restored, but there are disturbing evidences of a weakening of America's implicit faith in schooling. Thus the fact that for two or three years college graduates have not been able to find employment has disillusioned many parents and young people as to the value of going to college. Then the fact that the leaders who guided us into such a depression are products of our schools, has raised a questioning attitude as to how far schooling really does help people to become more intelligent and to develop truer scales of value. With such a public attitude developing, it seems to me very dubious whether the school expenditures will automatically return to the 1929 level when prosperity comes back.

In support of this prophecy attention is directed to the Citizens' Councils for Constructive Economy that are being organized in many communities. Each of these is studying the local government budget to determine how much is spent for schools, for police, for fire protection, and for other public services and then evaluate each in terms of value received for the money expended. Henceforth the amount expended for schooling will depend on how much the public appreciates the values received from schooling. If the public is convinced that educational institutions are helping the people get a larger degree and a finer quality of growth, there will be plenty of support for schools that render this service. The spread of the Wisconsin idea in the early years of the twentieth century and the consequent steady increase in state appropriations for the University of Wisconsin is evidence supporting this conclusion.

The Wisconsin idea was appropriate for its day. A similar opportunity challenges universities at the present time. If they produce an idea that is equally appropriate to the present day and if they deal with it as Wisconsin dealt with it in 1900, they will surely get public support and the financial outlook will be better than it has ever been before. What is the big idea that will do that?

We all agree that we are in the midst of a radical change in the basic relationships between government and business. The critical feature of this change is embodied in the Recovery Act. That Act substitutes controlled coöperation for restriction by legislation, as the means of securing greatest public welfare. To this

end each large industrial group is asked to formulate what they call a code which defines the conditions under which that industry thinks it best operates in the public interest. It is explicitly stated when an industrial group has agreed to a code, that code will have the authority of law which the federal government will enforce instead of the anti-trust laws. That is a very fundamental change of base. The government no longer will attempt to control industries by anti-trust laws designed by legislatures to restrict action. The government now proposes to enforce codes determined by voluntary coöperation among all concerned. These codes are experimental and will be changed from time to time when experience shows that they are not working properly.

This change from autocratic control to controlled coöperation is not new. It is implicit in our Constitution. Industries and the government have been experimenting with it for a good many years. The evolution of traffic regulations from speed restrictions to centralized control that expedites traffic and liberates drivers, is a good example. The principle involved in them all is called the principle of centralized control, with decentralized responsibility. That is the basic principle embodied in the Recovery Act. It is an experiment on a national scale to discover what features in each industry should be centrally controlled in order that all may have greatest possible freedom and responsibility.

If the schools train people to take part intelligently in experiments with centralized control and decentralized responsibility, they will make such a contribution to American life in the next ten years that there will be no question at all as to their financial support. Significant experiments toward that end are now being made in the General College at the University of Minnesota, in the extension work at the Universities of Nebraska and Oregon. These experiments are described in the July number of the *Educational Record*. The common characteristic of these experiments is that they liberate students from restrictive requirements and place the responsibility for learning on the student himself. The students then do the work instead of the faculty, and learn by experience to operate in accordance with the principle of centralized control with decentralized responsibility. The cost of the instruction by this process is much less.

Experiments of this sort develop schooling that liberates latent talents and helps people get from the present a larger degree and finer quality of growth. They indicate how a more vital educational result can be secured at lower cost. Hence, the first step toward financial recovery of schools is to develop such more vital schooling on the present reduced budgets. People will appreciate

this service and will express that appreciation by increasing steadily financial support.

The opportunity for such service was never greater than it is today. A new social and economic era is dawning. The financial outlook for these institutions that best help people learn to play the new game was never as bright as it is today. If schools meet the present challenge effectively, the people will be spending a great deal more than one-half of 1 per cent of this national income on institutions of higher education ten years from now.

FACULTY ASPECTS OF UNIVERSITY ADMINISTRATION *

By DEXTER S. KIMBALL,

Dean, College of Engineering, Cornell University

In the minds of many educators the ideal university of all time was Plato walking in the groves of the Academy imparting knowledge and wisdom to those who choose to listen purely for their own edification. In Modern American parlance this form of instruction has been described as "Mark Hopkins sitting on one end of a log and a student on the other." For a limited number of students and for teaching in its highest form the general idea is, no doubt, logical and sound and verified by the history of teaching throughout all time. Such instruction is simple, effective and comparatively inexpensive.

Two influences have operated in modern times to make this form of instruction the exception rather than the rule, namely, the great growth in knowledge, particularly scientific knowledge, and the modern idea that higher education should be accessible to all who can by any means enter the university. These influences have made necessary the modern university with its large monetary foundations or state grants, expensive buildings and laboratories, specialized instruction and a large amount of mediocre and poor teaching, much of it by young and inexperienced instructors. Hence arises also the need of trustees competent to administer large and difficult financial problems and the highly organized and expensive machinery of university administration.

No sensible person will question the need of a wise board of trustees under such circumstances. They are necessary for two principal reasons, first that which has been referred to and second a modern faculty needs some group of wise persons who can view the problems of the university from a somewhat more distant viewpoint than that of the faculty in order that all general policies may be wisely directed. Such boards should, therefore, have a goodly number of alumni in their councils.

Boards of trustees or regents are naturally invested with great powers both as to the inauguration and administration of university work. They have the final word in the selection of the faculty

* An address delivered at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 4, 1933.

and can approve or disapprove of any and all university activities. The wisdom with which this power has been used has varied widely. At one extreme are instances of wise and tolerant administration that leaves little to criticise. At the other extreme are many instances of arbitrary and intolerant administration wholly unworthy of the cause of education, the teaching staff being looked upon simply as "hired men" and treated often worse than factory employees. Such conditions are to be expected in a new country such as ours where financial control of education is often placed in the hands of men who, while good business men, may be totally lacking in educational ideals and standards.

As we have acquired experience with university problems it has become increasingly clear that these problems cannot be divided into two independent groups, financial and educational, but that they are one and the same. The business of a university is to provide educational facilities and the board of trustees has other functions besides fixing salaries and erecting great buildings simply to commemorate the name of the donors. Some boards have even had the courage to decline great gifts which did not fit into their educational program, but such courage is rare. It has become increasingly clear that no board of trustees can intelligently administer educational funds without full and definite knowledge of the problems involved. Of course the president usually is expected to present these educational problems to the board of trustees and in many cases this is done in an admirable manner, some presidents indeed being real educational leaders. But, after all, the president is an administrative officer and hence more inclined, I believe, to take on the attitude of the board rather than that of the faculty. Furthermore, presidents, deans, and similar officers are usually objects of suspicion, more or less, on the part of the faculty, and there is a wide-spread feeling among faculty men that such administrative officers do not always represent faculty opinion and consequently there is a growing sentiment that there should be more definite means of expression on the part of the teaching group. Not that teachers have any idea that we can return to Platonic methods, nor do they have any illusions, I believe, as to their ability to direct the financial affairs of a great university. But there is without doubt a growing opinion that American universities will never rise to their highest effectiveness until educational needs are placed first and foremost in the councils of the board of trustees. There is no difficulty in finding on any American campus ample illustrations of large expenditures that would have been much more intelligently directed had the consensus of best faculty opinion been first obtained.

So far as the writer is aware, few real efforts have been made to

bridge the gap between these two important groups. One of the most outstanding experiments in this direction was inaugurated at Cornell University in 1916, an institution with a remarkable history of intelligent and tolerant administration on the part of its presidents and board of trustees. In that year on the recommendation of President Jacob Schurman two innovations in the management of the University were established. The first was the election by the Faculty of the University of three representatives to the Board of Trustees. One representative is elected annually and the term of service is three years. While the plan perhaps has not done all that its proponents hoped, it has given a large number of faculty men a chance to express their opinions before the Board and also has given them a much clearer idea of the work and the problems of the Board. On the part of the Board members also the plan has been educational and the principle appears to be well established at Cornell University. When the present President, Dr. Livingston Farrand, was selected the three faculty representatives were members of the committee charged with the responsibility of recommending men for the position.

The second innovation was the election by each of the faculties of Arts and Sciences, Engineering, Law, and Architecture of a Conference Committee of three professors who could meet with the President or the several committees of the Board on any matters of interest to the particular faculty concerned. This part of the plan has not been effective but out of it has come another idea that may be more fruitful. For many years a committee consisting of the President, the several deans, the Secretary of the University and the Director of Admissions has served the University Faculty as a Committee on University Policy in all matters of general interest to that faculty. This committee while functioning fairly well was of course open to the general distrust of all such bodies that are composed of executives and last year by vote of the University Faculty a new elective committee on policy was authorized. The three faculty representatives are also members of this committee, thus affording a direct avenue from the University Committee to the Board and providing a new way of expressing the faculty viewpoint to the Board. This new venture will be watched with great interest.

The position of president in a great university is one of the most difficult and trying of tasks. Whatever other relations may be established between the board and the faculty, he necessarily must remain the most important intermediary between the two groups. To be successful he must enjoy the confidence of both groups, no light thing to accomplish when it is considered that at his best he is an educational leader, an executive officer, a father

confessor to unfortunates, and in many ways dictates the financial expenditures. I know of no position that requires so much wisdom, tact and personality to be successful, and there are few that rise to great heights in such work. The most common cause of failure that I have observed is arbitrariness. Of course, a president must make many quick decisions in order to perform his many and varied duties, but the art of seeking sound advice on major questions from those around him who are capable of giving such help is not so common as it should be among university presidents, and this holds also for other university executives. It is particularly true of deans and heads of departments, who also are executives and financial agents and should be educational leaders. Their problems are like those of the president though of somewhat lesser magnitude and they should be selected with the greatest of care. It is quite customary for the president to nominate deans to the board without consultation with the faculty concerned. No doubt there are cases where this is justifiable, but in general it is better policy to consult the group concerned before making such recommendations. The success of a dean depends largely upon his relations with his faculty and it is worse than useless to interject a personality into an academic group who is not acceptable. At Cornell University this is recognized by a statute of the Board which states that deans shall be appointed by the Board on the nomination of the President, "there being submitted with the nomination the opinion thereupon of the faculty of the college of which the dean is to be appointed, the opinion to be ascertained in such manner as may be determined by such faculty."

This general principle of conferring with the group concerned in all cases of recruitment is basic and important. No professor or assistant professor should be recommended without careful consideration of the group in which he is to be placed and if the opinion of the group is overruled there must be some overwhelming advantage in making the appointment.

Finance and budgeting are treated in another paper and will not, therefore, be discussed here. But all that has been said concerning coöperative understanding of academic questions holds equally for all financial matters. In most universities the expenditure of all funds must be carefully supervised and for that reason care should be taken that fairness is observed in the distribution of appropriations. The writer is a firm believer in departmental appropriations for running expenses. It helps professorial dignity to have some funds, however small, that can be spent without lengthy discussion and explanation with some one higher in authority.

If the professorial group desires and expects cordial and fair

relations with the board of trustees they should in turn try to establish familiar relations with the student body. It would appear sometimes as though little was done in this direction. If, as the faculty sometimes assert, the general administrative machinery of the university is too cumbersome and expensive, it is equally true that the academic machinery is often equally burdensome for the student. The faculty apparently often loses sight of the fact that the principal object of the university is not to offer courses and combinations thereof, but rather to give students a chance to develop whatever talent they may possess. A general house cleaning of academic machinery and a simplification and strengthening of the relations between student and professor would do much good in many places. If the conditions should be such as will make the professor contented it is equally true that they should be such as will also make the student contented. This is particularly true of social regulations. These should be as few and simple as possible and should always be fair and reasonable. Since the days of Plato there has been no other basis for satisfactory human relations other than justice and the square deal. Conversely, the student who cannot live under such liberal conditions without making a nuisance of himself should be excluded without delay. A university should in no such sense be a reform school.

Satisfactory conditions such as have been described cannot be created off-hand; they are in most cases the result of long and careful adjustment. Much depends upon the early beginnings of the institution. The degree to which the first faculty of an institution can shape the spirit and atmosphere of its after life is remarkable. A university that possesses a liberal administration and a satisfactory family life is the shadow not of one great man, but of many wise administrators on both board and faculty. Not enough thought has been given to the creation of such an atmosphere in many institutions.

If it appears that I have stressed the need of better appreciation of the faculty, it has been done deliberately. I am well aware that in the minds of many the professor is visualized as a temperamental individual, wholly immersed in his books, ignorant of the ways of the world and rather incapable in administrative matters. It is true that many of them are temperamental; all highly developed organisms are, but like the proverbial cow they do their best work only when they are contented. It is true that some of them are immersed in their studies and researches almost to the exclusion of all other matters. But from these studies come the things that move the world, eradicate disease and make life richer and happier. The world of to-day is largely the result of the professor and his laboratory. He is worthy of the best of care.

As to knowledge of world affairs the faculty of any great university contains a very large number of men whose knowledge of such matters is not to be found in any group of equal number elsewhere. It should be remembered that the first great book on political economy was written by a college professor and many of the best known works of this kind have come from the teaching profession. The present administration at Washington at least appears to have some faith in professorial opinions of government. Lastly, faculty men as a whole so far as honor and integrity go rank with the highest. If fairly treated, they will, with occasional exceptions, give the best there is in them and when their influence upon our civilization is considered it appears to be a small request that the administration of our universities take into account the need of providing such surroundings as will permit them to develop to their highest efficiency. The one greatest asset that a university can possess is a strong faculty. With it the university may be great, without it no matter what the buildings or equipment it can be nothing more than mediocre. While *legally* the Board of Trustees is the University, *spiritually* the university is the faculty and by their works it shall be known and appraised.

SELECTION AND DEVELOPMENT OF FACULTIES*

By J. W. BARKER,

Dean of Engineering, Columbia University

We strike the vital point in this problem, when we compare it with the family problem, the family problem of seeing our younger men develop, increasing in power and capacity, and gradually taking over the primary responsibility in our faculties, and the feeling on our part that we have had some slight hand in that development. We, however, are somewhat more fortunate than average parents in that we do not have to take what the good Lord gives us. We have a certain selective possibility in front of us. In that selective possibility it behooves us to set up a job specification, to call to our minds frequently those qualities which we deem desirable in our senior staff members and those capacities which we should look for in these junior members, whom we are considering appointing to our staffs.

I am in a fairly difficult position, because many of the points I was going to stress have been stressed by Dean Kimball last week in Chicago. As Dean Kimball said, scholarship is the primary requisite which our young appointees should have. Without true scholarship most men cannot proceed far in the educational profession. They may become good laboratory technicians without scholarship but not inspiring teachers; and that scholarship must be of a very high order. It must not be confused with the mere ability to impart information that has been given out by some other professor, absorbed by the individual, and thus assumed to be scholarship. That is not scholarship.

We should look for the qualities that lead to scholarship in these younger men. Such scholarship, however, must be broad and catholic in its interest. If we are to prepare the students who come to us for places of prominence in the civilization of the present and immediate future, we must inspire our students; and if our staffs are made up of narrow technicians, this inspiration will be limited and narrow. I do not mean that the instructor should think of himself as a "jack of all trades" and that his interest should run high, wide, and handsome over all knowledge, but it should be broad and catholic.

* An address delivered at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 5, 1933.

The interest and the capacity for scholarship must be capable of continued development. These, of course, are difficult to judge. It is like looking at a horse and asking how far can he run? The young man must be capable of developing along the lines of his specialty. He must be willing to learn from his seniors. We have in the Engineering profession to-day a number of inspiring and distinguished teachers and it behooves us to look at the juniors and see whether or not they have the capacity to learn from the older men. Does the young man have the ability to mould himself and is he willing to accept suggestions from his worthy superior? Then scholarship and inspiration are the prime prerogative.

Next I have placed character. Engineering is a group of subjects developing high character and requiring high character for their development. As Dean Kimball so aptly said last Thursday night, if we were attempting to teach burglary, we would take a burglar for a teacher, but he would not have high character. Faculty members must also be exemplars of high character to their men. As Dean Lapham says, faculties must consist of men who can and do act as catalysts, those accelerators of reactions.

Next on my list is the power of exposition. The power of exposition is a very useful attribute in a good teacher. In my own short experience I have seen some men, who by a very simple, easily understood example could make the most abstract subject live. You have all known that in some teacher that you had. We have all known teachers, who have not had this quality, and who have had to hold their students' noses to the grindstone to get results instead of getting them to understand the material by giving them a clear-cut example.

Under exposition I have listed the implanting of germs of thought in other people's minds. I like the idea because it makes the student do the work and not the teacher. Furthermore, as a second point, abstract knowledge is not what we are attempting to give: we are attempting to instill in our students the ability to learn; not mere factual knowledge, but the ability to learn. We are not so greatly interested in how much the student knows as we are in how he can apply the fundamentals he has learned. Teaching also involves visualization.

Another quality we look for in a teacher is that of vision and foresight. The educational process ceases only with death. It is a process in which we can only expect to start the student in the hope that some day or other he may become an engineer. Engineering methods move swiftly, hence education in engineering must move swiftly. Methods that were good enough for our fathers are not good enough for our students to-day. That is why

our young teachers must have vision and foresight. They should not be attempting to teach present practices alone which are likely to become obsolete almost before the student gets into the profession. Teaching engineering requires vision. We want our students to have vision; and if our teachers do not have it we cannot expect it in our students.

Then there is that outstanding gift of humor. Many teachers have failed because they did not know when to laugh or tell a story to relieve the tension. A joke drives the point home better than a hammer. A laugh is better than a call-down. How many times has a scolding raised antagonism when a laugh would have won the class to the teacher's point of view. Many a teacher has failed to be an inspiring teacher because of a lack of humor. It is a God-given quality.

Another important quality in a teacher is the desire to see the young mind grow. On my part I feel that being an educator means more to me than the dollars I get. It permits me to live again in the lives of the students that come under my influence. I am molding these men when they come under my influence; and I feel that my influence is not over when I go to the grave, because I shall be alive in the minds of these young men whom I have influenced in the classroom.

Finally, an inspiring teacher should have patience with and love for a young man. That is a very important point.

No one man possesses all of these qualities. That is perfectly obvious. It would be utterly ridiculous to say that every man should have these qualities to the nth power. But they are the factors we should look for and attempt to evaluate in the men we hire as teachers. Does the new man have power to develop along these lines? Furthermore, can we help the young men on our staffs develop along these lines? We must not simply appoint them and then sit back with the axe to chop their heads off if they do not develop. It is up to us to help them develop these qualities that have been outlined. We should develop within ourselves a power to see them in a young man at an early stage of his career.

Good teachers don't grow on trees. They are the product of much labor by their seniors. The most important influence in my professional life was D. C. Jackson. Jackson took an enormous amount of care with me when I came out of the Army. It was his dropping of an idea, his getting me to develop that idea so that I would take it back to him as my idea that helped me very much. Jackson saw many of my shortcomings, and if I only had the capacity of overcoming those he has told me about, I would be a much better teacher and a much better man than I am. His

directive influence has been an enormous help in my life. Every one of you has been subject to similar influences. Are you in your turn doing as much for the young man on your staff? It takes work to do this and it takes interest in the young man.

In developing a teaching staff there must exist a tendency toward cross-fertilization. Avoid inbreeding. This is important. It is often much easier to appoint one of our own graduates, because we feel we know him better than some one of another college. Sometimes this is right; but have you questioned his ability to bring new ideas into your staff conferences? If he is the product of your own group, he probably will not. We all tend to grow along the lines on which we have been directed. We must develop in ourselves the willingness to work with our junior staff members and to train them. This frequently involves shifting the young man from one type of work to another so as to broaden him in his earlier days. It does not seem to me to be fair to put him in a certain laboratory and leave him there. We have a duty to these younger men to move them around so as to give them a broadening experience in their training. It is difficult, but the end result should be effective.

There is much to be said for the practice of class visitations by senior members of the staff. Again I think one of the greatest influences that came to me was the help I received when I first started teaching from senior members who visited my classes. After their visits they would talk to me and point out my mistakes, not in a spirit of criticism, but simply to give me the benefit of their wider range of teaching. For example, in conducting class discussion work a young man usually does too much of the talking himself.

Group conferences of those teaching the same or closely related subjects can be profitably employed for the exchange of ideas. With large departments and many sections devoted to the same subject, it is necessary to have these discussions. In such group conferences, points that a student has brought up for discussion in one class can frequently be taken over in another class the next day to the profit of the young staff member. The group conference can be a powerful influence for good.

In discussing the question of how long after graduation should a young man stay on the staff, I am giving my own personal ideas. I do not believe that it is fair to allow a recently graduated instructor to continue teaching more than two or three years on the same staff. Two or three years of teaching in one department is long enough immediately following graduation. At the end of such an assignment the young instructor should do one of the following: (1) Obtain practical experience for three to five years,

(2) take up teaching elsewhere, supplemented by practical work in the summer, and (3) attend summer sessions elsewhere supplemented with periods in industry.

The young instructor should also be given an opportunity to do work on faculty committees. I believe in putting a group of young men on committees without having an older man to hold them down. Let them boil their ideas down and come to you with the results, some of them ridiculous, of course, but don't laugh at them. They will work twice as hard as the senior members of the faculty. Such experiences have a broadening effect on the young man. Ideas themselves don't go very far. It is the working out of those ideas, which is important. Senior representation mixed with juniors on some planning or investigating committees is valuable as an introduction to cross-relationships of departments and schools.

Migration that is not caused by less attractive salary scales in your institution or by a closed promotion list, is helpful. If caused by such circumstances, migration is necessary but not necessarily desirable.

The last point I wish to stress is that of the development of the social side of faculty relationships and of faculty-student life. In my student days some of the most interesting and valuable experiences I had were at the afternoon teas Professor and Mrs. Jackson used to give at their home at which students and faculty met over a cup of tea and learned to know one another as would have been impossible in the classroom. Many students, who have gone to teas, have said on the way back: "That professor is really a man." The same holds true for inter-faculty relationships. When we meet one another solely at the University there must be necessarily something businesslike about it. But when we meet at the Faculty Club, at smokers, and at dinners, we begin to know our colleagues more intimately and to appreciate their good points.

A wife can be an enormous influence, for good or bad, for a faculty member. Many a good man has been broken and many a man completely made by his helpmate. You can't control whom a young man marries, but you can help him to meet the right people. These social aspects of faculty relationships mean much to me. I feel they can teach the young men to appreciate the possibilities of University life. Of all the buildings at Columbia University the most important building is the Faculty House, because it has done more to coördinate that institution into one unit than anything else we have on the campus.

FUNCTION OF THE ADMINISTRATIVE OFFICER WITH REFERENCE TO GRADUATE WORK *

By DUGALD C. JACKSON,

Head of Department of Electrical Engineering, Massachusetts Institute of Technology

The subject on which I have been invited to address this Round Table has several important aspects. One relates to university policy and touches on the needs which exist in the engineering industries; and particularly the need for young men of notably high intelligence who have been educated to a high degree in the engineering sciences and in some instances concurrently in political economy. Another aspect is equally important but is immediately bound up with improving and maintaining the matter and manner of engineering education and with the administrative aura competent to stimulate suitable matter and manner.

The matter and manner of engineering education, broadly recognized as affairs of pedagogy and of scientific research, conjointly constitute the foremost feature of educational procedure which conspicuously presses for our consideration in the engineering schools. They deserve the sustained earnest attention of the faculties of foremost engineering schools and also a prominent place for discussion in convention programs of S. P. E. E. Such discussions can become an inspiration and a guide for appropriate educational thought, and thus contribute to the further development of our processes.

However, the discussions of this Round Table are more limited and pertain to administrative aura *per se.* I shall sketch these as they seem to me to relate to carrying on graduate work, and will set up a skeleton frame-work on which the referred-to educational procedure relating to graduate work may be supported. It is desirable to have this frame-work clearly outlined in our minds before the establishment of graduate work in the engineering schools has become more widespread. Of course my picture of the referred-to administrative relations will or will not appeal to you, depending on whether or not you will accept my definition of the correct connotation of a phrase like "graduate work in engineering."

The definition which, in my opinion, is applicable to that phrase, as such work should be pictured in the engineering schools,

* An address delivered at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 5, 1933.

is somewhat descriptive. Graduate work in engineering is a deeper and more intensive cultivation of a special field of study within engineering than may be compassed in the inherently broader work of four-year undergraduate engineering curricula, however high the scientific and economic contents of those curricula may be. Such graduate work should be subsequent to and rest on preparation available from a suitable undergraduate engineering curriculum. Appropriate depth and intensity can be achieved only by making the graduate work intrinsically individual and of highly investigative character. This denotes that each student's work shall be carried on under the encouragement and direction of a teacher or teachers of leading and scholarly mastery in the special field of the student's choice; and each such teacher must have sufficient respite from conventional hours in classrooms and laboratories so that he may give productive contemplation to the particular qualities and ambitions of each individual student.

The definition excludes from the term "graduate study" further formal study which may be pursued within the undergraduate level after securing a Bachelor's degree, because the undergraduate work is only an approach toward the criterion of deep and intense investigative study in a special field. Therefore strictly undergraduate subjects are excluded from the scope of the definition.

The distinction is very important for it profoundly influences the pedagogical ideals, the character of teachers and equipment, and the administrative arrangements appropriate for carrying on instruction of graduate students. Pedagogical ideals, teachers, equipment and administrative arrangements that serve excellently for freshman and sophomore work and passably well for junior and senior work of usual types in our engineering schools are rather ineffective and entirely inappropriate for graduate work. In reverse, however, proof is plentiful that the pedagogical ideals, teachers, equipment and administrative arrangements most fruitful with graduate students are equally fruitful when properly utilized with seniors and may be serviceably utilized with juniors. They may be utilized to a moderate extent even with sophomores. That is, the American engineering students of twenty years of age and upward, who should be retained in the schools, with few exceptions are young men of intelligence and ambition who respond effectually to the stimuli of conferred responsibility and expressed respect for their abilities. The excellence of preparation for both graduate work and for engineering employment which any student secures from his undergraduate studies depends upon the degree to which the work of the senior year, and to some extent of the junior year, has been developed to an investigative character, and the extent to which the student has embraced his opportunities.

We may now examine the administrative relations which the introduction of sound graduate work imposes on an engineering school. For convenience this may be referred to as relations to staff, to equipment, and to budget. We must recognize a distinction between staff and facilities which are appropriate for carrying on work which leads students to the Master's degree on the one hand and leads to the Doctor's degree on the other hand; just as we distinguish between those which may serve for conventional undergraduate work on the one hand and proper graduate work on the other.

(1) **Staff.**—Much that may be said regarding the qualities of staff requisite for carrying on the best undergraduate work as well as for graduate work is directly stated or inferred in my paper presented at the recent Convention of S. P. E. E., entitled "Intellectual Interchange Among Faculties of Engineering Schools."

As far as staff is concerned the administrative duties which have reference to graduate work are to first understand the needs of the work, then secure and maintain an appropriate staff, and finally provide the staff with facilities. I am not an administrative officer of an engineering school but am a professor with a love for the contacts of engineering practice and also for the reflective life of teaching and research. As head of a department I have had the happy experience of finding myself associated (by means of gradual accretions) with a large staff which is internationally recognized for its many-mindedness and vitality in combined teaching and research in electrical engineering. This fact, and an additional one, that during the course of years I have served with the direction and support of a series of capable and sympathetic administrative officers, perhaps make the grounds on which the Committee justified their invitation for me to open this discussion. I view the administrative officer objectively. Dean Seaton the next speaker deals with the aforesaid officer subjectively and he may feature some of the facets and some of the difficulties which I overlook.

A man possessing a usual engineering education who has interest, industry and devotion may do well in conventional undergraduate teaching when assigned the not unusual personal responsibility for three curriculum subjects with accompanying fifteen or more hours a week of specific occupation in the classrooms and laboratories, and such a one still may have time for the necessary daily and weekly preparation which is requisite to carry on such work conventionally well. A choice of reasonably good textbooks of traditional character is now available for almost any engineering subject.

Such a heavy allotment of specifically assigned hours, however,

is a preventive of the best originality and resourcefulness in undergraduate instruction. It is quite out of keeping with making an inspiring success in graduate instruction. Here the usual textbooks are too meagre and joint recourse must be had to advanced textbooks of illuminating quality, treatises, original published sources of material, and the time-consuming development of resourceful original measures by the instructor, for guidance of the intellectual processes of the students. Moreover, the treatises and original sources coming into the purview are not solely those within the instructor's own chosen field of mastery but include those in collateral branches of engineering, associated sciences and sometimes political economy. For simple illustrations of what I mean by recourse to treatises, it is sufficient to say that Rayleigh's treatise on "Sound" is a wonderful vestibule to the rich understanding of many aspects of electrical engineering, and mathematical treatises on the theory of elasticity are equally contributory to richness of understanding in some other branches of engineering.

The administrative problems of staff which are related to our topic simmer down to selecting men of suitable intellectual qualities and industry, encouraging their ambitions, and limiting their assigned *specific* teaching hours. Given moderate proportions of space and equipment, men of masterly quality thus supported will inspire graduate students who will gather around them, and they will prove to be very busy creative men of richly productive results for engineering education and engineering practice.

When an engineering school has one masterly man thus chosen and supported the Dean is justified in advertising that his school is ready to guide suitably prepared graduate students, under the direction of that man and in his branch, and to confer the Master's degree for successful work. In my opinion, no engineering school is justified in making any suggestion that it undertakes graduate instruction unless it possesses this minimum of requirements. It of course is better if any such institution supports in the manner defined one or more such men in each of a number of branches of engineering; and also that the contributory branches of science in the institution, especially mathematics, physics and chemistry, are equally alive. The mature student who during his student career fails to glimpse the ideals, the spirit and the resourcefulness of several men who are masters, each in his chosen field, fails to embrace fully the opportunities for education. Unless this can be fulfilled on a particular site, wise consideration of the welfare of each capable student and for the engineering profession will lead the administrative officer to advise students to pursue at least part of their graduate study at some site where the stated conditions can be obtained.

The foregoing relates to graduate work leading to the Master's degree. More complete requisites underlie preparing students for the Doctor's degree with "major" work in any branch of engineering. The Committee on Graduate Instruction appointed by the American Council on Education is now actively at work gathering data regarding facilities for study leading to the Doctorate in American institutions of higher education, using questionnaires covering a large number of individual branches of learning, among which are included several of the major branches of engineering. These questionnaires ask for explicit designation of engineering schools which can provide "adequate guidance and facilities for graduate work leading to the Doctor's degree" in the branch of engineering concerned. The engineering schools do not have a mutually intelligible formulation defining "adequate guidance and facilities for graduate work leading to the Doctor's degree" in any branch of engineering; and the S. P. E. E. has not yet made such a definition. It is desirable for the administrative officers and faculties of the engineering schools to give thought to this question, or else we may come to the inappropriate situation wherein the stamp of the degree on mediocre persons may come to take precedence over true achievements of real minds which have not the stamp of the formal degree. Some of our colleges of arts seem to have had this unhappy situation somewhat forced upon them by classification rules heretofore adopted by their organization. We in engineering have the opportunity to avoid such a mischance.

Each major branch of engineering is a vital and extensive field of learning and practice stretching from the so-called natural sciences, particularly mathematics, chemistry, physics and biology (with the emphasis on each depending on the branch of engineering) into finance and political economy. Adequacy of guidance and of facilities for "major" graduate work leading to the Doctor's degree in any branch of engineering therefore connotes a rather large staff comprising members with distinction in various aspects of the work, which aspects extend from the mathematical treatment of simplified engineering problems, through a wide range of aspects related to refined marshalling of selected sciences and economics to problems of design, construction or operation of machines and plant, and thence to topics relating to the influences on organized society of the expenditure of vast sums of money within the field such, for example, as the influence on the conditions of life of costly networks of hard-surfaced highways, modification of rail communication and of structures, electrical communications, conversion of water power into electric power, and so on.

In addition to such a staff, equipment should be available for carrying on experimental research, besides important library facili-

ties affording opportunity for mathematical and historical research and project development.

An appropriate doctorate in any major branch of engineering requires that the student shall have pursued his "major" work under proper guidance and with proper available investigatory facilities either (1) in the natural science aspect of his field, or (2) in the political economy aspect of his field, or (3) in the intervening areas of learning; and with this "major" work there is ordinarily associated a "minor" or in one of the sciences like mathematics, physics or chemistry (or some other, depending upon the student's particular branch of engineering), or in some aspect of political economy. This definition affords opportunity for choice between experimental research, research of a mathematical or historical character, and projects of designing, all of a high order. It is to be remembered that research means detecting and identifying facts and discovering their relationships. Therefore, the processes of making ordinary tests by well known techniques for the purpose of determining specific numerical values of previously known properties do not usually qualify as research.

Doctorate instruction is expensive, only a lesser proportion of graduate students are ambitious for and appropriate to such work, and it is for the administrative officers of each engineering school to determine when, and whether at all except perhaps in special cases, the school shall undertake to provide the "guidance and facilities" for such work. In consideration of the best interest of doctorate students, the best repute of engineering education and the best regard for the engineering profession and the engineering industry, it seems to me that the administrative officers of each engineering school should refrain from advertising a readiness for doctorate work until quite sure that it can be permanently supported by staff and funds; and that preferably such work should then grow as a development from and associated with a continuation of previously successful master's work.

Graduate instruction of a level appropriately leading to the Master's degree is likewise of level appropriate to the preliminary graduate year of doctorate students. The administrative officers of any engineering school which can provide the requisites for competent graduate instruction leading to the Master's degree will find that the establishment and successful prosecution of Master's work as an established feature of the school will collaterally and by mere association prove itself a vitalizing influence for the spirit of the undergraduate students. Successfully prosecuted graduate instruction which leads to the Master's degree thus serves to strengthen the standards of the school, which is a point for the administrative officers to consider. However, let me add the cau-

tion that graduate instruction in an engineering school is serviceable only when suitable staff is available and reasonable freedom from conventional time assignments can be sustained by the administration. Perfunctory graduate instruction is damaging to the standards and reputation of any engineering school and good administrative judgment will avoid it sedulously.

(2) **Equipment.**—The subject of equipment which is required for graduate work can be elaborated with many words or dealt with in few. Research, an essential part of engineering education, of course becomes emphasized as the students increase in intellectual level. The research therefore gathers in importance for graduate work. However, a staff member who clamors for a large allotment of funds in order that he may "start some research" is usually a man whose judgment is poor. Extemporization of apparatus from materials available and utilization of some unused corner, perhaps sweetened by a few available dollars, is the best route to be pursued by a resourceful professor and competent advanced students. The desirability of the project and the fertility of the man in charge, having been proved, then the functions of the administrative officer come into play to further encourage the man and secure appropriations for carrying on in a proved pathway.

(3) **Budget.**—These are not times to propose additional expenditures to administrative officers of engineering schools. I do not propose to do so. It is my opinion that a number of engineering schools where graduate work has been made a feature of the catalogue, but where it has not yet become an influence on the student body, are now in a happy situation for the administrative officer to bring about improvement by encouragement and by relief in some degree from conventional time assignments, both offered to judiciously chosen staff members. Such encouragement and relief should be made for the purpose of enabling such members to give greater concentration to the mastery of their chosen specific subjects and to the inspiration and guidance of a few ambitious students who are desirous to work toward a Master's degree. Such students may be expected to carry on their reading and investigations with considerable independence within a prescribed field, but with intimate consultation with the responsible staff member or members.

Since the expectation of a smaller attendance of undergraduate students during the next academic year seems to be the rule in the engineering schools, this plan may be practically utilized in at least some schools by judicious assignments of work without increasing materially any teacher's load. Moreover, in times like these, some chosen students will fulfill an ambition by taking up graduate

study though they would be guided by an irrepressible impulse for financial independence and the romance of industrial employment if promising employment were available. Therefore promising graduate material is likely to be available among the students in times like these. If the project is established and successfully carried on it is not an unsound prediction to suggest that funds for continued sustenance of the improvement can be secured as times and appropriating bodies become more hopeful.

There is one additional precaution that I perhaps ought not to overlook passing on to administrative officers: namely, that if this project is established and successfully carried on, promotions among the staff will have to be thereafter more selective than heretofore, with achievement receiving greater weight compared with seniority than has been customary, or the project will wither out.

Successful prosecution of this plan will also give general illumination in any university circle which is not already well informed respecting the dignity and scope of engineering, the major importance of science in engineering education, and the relative importance of science and of empirical practice as components of such education. After such illumination has been effected it should be easier to secure support for reducing overonerous time-assignments of undergraduate conventional teaching loads which type of assignments result in shallow performance by the teachers and deficient cultivation of science by them.

ENGINEERING EDUCATION IN THE LIGHT OF CHANGED SOCIAL AND INDUSTRIAL CONDITIONS *

By WILLIAM E. WICKENDEN,

President, Case School of Applied Science, *President*, Society for the Promotion of Engineering Education

A Pause or a Turning Point?—The present conference is the culmination of a train of activities covering a decade of effort to develop, broaden, and enrich engineering education. It is significant that this effort began in the most opulent phase of our national existence and is ending in a period of unprecedented depression. Circumstances such as these forbid us to judge our work by the expediency of the moment or to content ourselves with improvements of detail. Even the most fact-minded among us is forced to take the risks of social forecasting. Is the present a mere pause in the march of society, or is it a turning point? There is a rather hard-boiled school of thought whose attitude is well expressed by the common French paradox, "The more everything changes the more it stays the same old thing." At the other extreme are those who see in the tribulations of today only portents of a dawning millennium.

Thomas Jefferson is said to have remarked that every country needs a revolution about once in twenty years. Most of them need be only violent enough to bring into authority new ideas, new sets of values, and especially new leaders. The periodicity of major epochs in American history appears to be about four times as long as the interval Jefferson suggested. To establish the colonial system, to raise it to economic and political self-sufficiency, to complete the expansion of the national domain while bringing two warring social systems to their final issue, and to establish an industrial order of society, have each covered periods of about eighty years. Signs that we have reached another such turning point are appearing on every hand.

Effects of Social Change on the Technical Professions.—The last two of the epochs just indicated have been highly significant for the technical professions and if a new deal is impending, the engineer is likely to find his work and his prospects di-

* An address delivered at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 6, 1933.

rectly affected. Opportunity began to beckon to engineers in America with the beginning of an independent and unified national life. The desire to make secure the national defense by military works, to bind the states together by improved communications, to assure economic self-sufficiency by developing industries, to open access to the great West and attach it firmly to the nation, and to provide public works for the newly developing cities, literally called the engineering profession into being.

With the warfare of social systems brought to a ruthless end in 1865, the country settled into the long and deep depression of the 70's, to emerge a wholly altered nation. To sense the depth and character of this change, one has only to call the roll of the dominant names of the half-century leading up to 1870 and contrast it with the leaders of the following fifty years—on the one hand, Webster, Clay, Calhoun, Sumner, Douglas, Lincoln, Davis, Grant, and Lee; on the other, Rockefeller, Carnegie, Edison, Bell, McCormick, Westinghouse, the Vanderbilts, and James J. Hill. America had passed from a period of geographical and political pioneering into a period of technological and industrial pioneering. Before, one who sought to grow rich and powerful acquired land; thereafter, he amassed capital and exploited labor, inventions or mineral resources. Business passed from the age of individual enterprise into the age of the corporation and the trust. Isolated railway lines were welded into transportation systems. Cities grew rapidly and the rural ideas which an earlier America had written into its Constitution began to yield a more urban, more cosmopolitan type of thought.

Parallels between the 1870's and the 1930's.—A series of striking parallels can be set up between the depression of the 1870's and that of the 1930's. In both instances a great war had strained both the material and the moral resources of the country, to be followed by a brief period of illusory prosperity in the industrial and mining regions and the grain belt. With the collapse of prosperity came the same derangements of money and commodity values, the same train of unemployment, of business failures, of bank crashes, of conflict between debtor and creditor classes, and of bitter personal hardships. Politically, one notes the same struggle for control between the executive and the legislative arms of the government. It is easy to press the parallel beyond sound logic, but the severity and length of the present crisis, as in the 70's, tend to make far-reaching readjustments fairly inevitable.

The upthrust of industry which followed the depression of the 1870's was due in large measure to power, fuel and metal, as limitations of supply were rapidly overcome. The entrance of electricity

into the realm of industry did for power what the invention of money had done in the early days of civilization for commerce. With water-power or steam alone only direct barter was possible; electricity supplied a circulating medium, infinitely flexible, capable of aggregation or subdivision, and easily transported to distant points. As yet, one searches the horizon with uncertainty for some major technical advance which will do for the 1930's what the coming of electricity did for the 1870's. Will it be aviation, or television, or air-conditioning, or light-strength alloys, or synthetic substitutes for natural raw materials? At the moment, no one or even all of them seem to have quite the lifting power needed to get industry out of the trough.

Economic Bases of a New Epoch.—Be that as it may, underlying conditions now, as then, seem to point to the coming of a distinctly new epoch. The recent one was marked by rapidly expanding production and rapidly rising population. Agricultural production per capita has been for thirty years or more at an apparent limit of expansion. The mineral industries in the same period multiplied their output relative to population by two and one-half and the manufacturing industries by two and one-quarter. Both, it appears, have increased their productive capacity in an even greater ratio than their output, and are possibly within the borderland of actual over-development. Potential or actual shortage of man power, which has been the main-spring of invention and of management technique in American industry, seems permanently to have been overcome. The late war marked a turning point in capital supply. Throughout the last century we were importers of capital and exporters of goods; the outflow of surplus products of our farms, mines and mills needed to balance the interest account reaching an excess of $600,000,000 annually over our imports. The war reversed matters, and we should need to accept an excess of one billion dollars in imports annually in order to receive four per cent on our loans abroad. The tariff dam which was built to insure our excess of exports under pre-war conditions now shows signs of being obsolete, if not actually an obstruction to our necessary trade.

Our unparalleled rise in population, which in the middle of the last century was proceeding at twenty times the highest average world rate ever recorded, now appears to be checked. Resource valuations built up on anticipated scarcity have been deflated, and industry may not be able for a time to prosper by its own expansion, borrowing against the future to expand its plant and converting the expenditure into added purchasing power for its current products. Our natural resources are now quite accurately known and almost fully pre-empted. Quick riches no longer await the

first man to discover and exploit nature's bounties. The country is settling down to the long-scale use rather than the hasty squandering of ore, coal, timber, and soil, and presumably will soon reach that stage in oil as well.

Changes in Social and Political Organization.—The present transition is not only economic, but social as well, and may be expected to result in significant changes in our political system. The goal of the pioneer's striving was self-sufficiency. To get on meant to acquire land, bring it under cultivation, escape debt, manage with the labor of one's family, supply one's own need as fully as possible—in a word, to become independent. To a population of which ten in eleven persons lived on the soil, as did the American people in 1790, that government was best which governed least. Interests were intensely parochial and school, church, bank, and government were to be as much as possible local institutions. Men feared centralization as an enemy of liberty and looked to the principle of local representation to safeguard their vital interests. Modern life, with its industrial and urban setting, tends to magnify corporate interests over purely individual interests. Men's occupations and their economic connections have become more significant indices of their vital interests than any mere locality of residence. In the modern world men largely prosper or fail as groups. Farmers, coal miners and bank depositors may be down, while brewers, tiremakers and annuity holders are up. The sea and the frontier no longer stand as guarantees of individual opportunity when adverse circumstances hem one in. The government which governs least, is not necessarily best, nor perhaps even possible. Rugged individualism is giving way before a broad socializing movement in which such non-political bodies as trade organizations, professional guilds, labor unions, mutual insurance and savings associations and farm coöperatives are becoming the actual functional units of our common life.

Summary of Basic Changes.—To summarize the altered conditions which foreshadow a new epoch: (1) adequate capacity to produce, with the use of barely one-third of the population to supply material necessities; (2) the stabilization of population with an altered scale of resource valuations and a lower pace of industrial expansion; (3) the reversal of our international economic position from debtor and exporter, to creditor and, in prospect, importer; and (4) the growing ascendancy of corporate over individual interests and of functional over political interests.

A New Balance between Agriculture and Industry.—The social readjustments to these altered bases of national economy are now beginning to take form. There is apparently a new

balance to be struck between agriculture and industry. Lowered costs and higher unit production have failed to make the farmer prosperous in the face of market limitations. The engineer and the chemist may now be called to his aid in order to broaden the industrial outlet for his products and to by-process his waste materials. A wider distribution of industry through the agricultural areas would make for rural prosperity, and aid in striking a new balance between city and country living. Cities, in their more congested forms, are largely products of technological forces which engineers are now able to reverse. When only animal, water or steam power were available, the worker had to come to the power. With only water and rail transport for heavy commodities, industry had to seek the traffic arteries. Before the day of universal electrical communication, concentration in one site was essential to executive control. All these limitations are now overcome, and the centralizing movement in industry appears to have passed its peak. Rural areas are fast approaching equality with cities in sanitation, comfort and cultural opportunity. If the land is to serve as a shock absorber for the annual and cyclic irregularities of industrial employment, through some combination of soil and job, a wholesale redistribution of industrial population may be impending.

Revaluation of the Rewards of Human Effort.—The striking of a new balance between consuming and producing power will inevitably carry with it a new valuation of goods, economic security, leisure, recreation and cultural opportunity as the rewards of human effort. Under an economy of scarcity, the assumption that men's material desires and their consuming power might be expanded indefinitely, was a justifiable working principle. Under an economy of abundance, this principle may not necessarily hold good. In a society where only three persons in ten are directly concerned in producing physical goods, men must expect to take a considerable return of higher productivity in intangible forms. Until now, nearly the whole weight of finance, research and education has been put behind the effort to increase production. Except for the seductions of advertising, little has been done to advance consumption or to raise it to a scientific level. Directly or indirectly, the scientific worker of tomorrow may have to look more largely to the consumer for employment.

Tariffs vs. Technical Superiority.—The new balance which is to be struck between our internal and our international economy bids fair to bring our historic tariff policy to a natural end. If the American employer and worker are no longer sheltered by a tariff wall, they may need to depend more on the protection of technical superiority, such as American engineering and mass production have already given to the automotive industry.

Protection against Technological Change.—The protection which employer and worker both desire is likely to be quite as much against uncontrolled technological changes as against foreign competition. The risk of supercession without warning has become one of the night-mares of industry. Economists agree that permanent technological unemployment is impossible but the hardships of transitional unemployment are known to be severe and are apparently increasing. A perplexed society is feeling constrained to make terms with the machine. Researchers and inventors for the first time in the modern world are facing the possibilities of social restraint or control. To the engineering mind, any suggestion to withhold from the public the benefits of improved knowledge and technique savors of pure defeatism. Why despair of the solution of a problem whose existence has only recently been recognized? In an emergency it is usually easier to impose restrictive measures than to achieve constrictive readjustments. It would be easier to slow down technological change by cutting off patent privileges or by burdening industry with dismissal bonuses or unemployment insurance, than to reduce hours of labor, provide for the retraining of workers and induce the public to adjust itself more quickly to new forms of consumption, and so to absorb a surplus of labor supply without undue delay and hardship. The easier way for the moment, is likely to be the perilous way in the long run. Men still need the spur of competition and we have a world of industrial rivals still to face.

Private Enterprise and Public Control.—There is a new balance to be struck between public enterprise and private industry. The most promising corrective which has been suggested for the cyclic variations of industry is to use the construction of public works as a regulator or compensator. When private industry slackens, it is proposed to increase the construction of public projects under a long-scale plan, and to reduce the latter as industry recovers. There is also a new balance to be struck between private initiative and public regulation. It is probably neither desirable nor practicable to apply the regulatory powers of government to the individual business or concern. Self-governing groups within industry, working under a code of fair and unfair practices and under some umpiring system sanctioned by the government, seem likely to assume a permanently increasing importance. In short, we may expect to see a type of government based on industrial and occupational interests growing up alongside of our present government based on geographical and political interests.

A Re-Orienting of Education.—There is a new balance to be struck between realistic and idealistic forms of education. Young

people are becoming relatively more scarce and adults of later maturity more numerous in our population. In the past century the age group above 50 has risen almost four-fold relative to the group under 20. Leisure is being transferred from youth to maturity. Young people come from school to face a world of work with thousands of highly specialized occupations, against which they must match their powers and interests, while their elders must increasingly find activities in the cultural realm if they are to be occupied at all. The answer appears to be a much more realistic effort in the high-school to fit young people efficiently into the world's work and the transfer of much of our national effort to create a distinctive culture to the realm of adult education.

Revaluing Utility and Beauty.—We may expect a new balance to be struck between utility and economy on the one hand and convenience and beauty on the other. Engineers need especially to take to heart the changing scale of values. We have too readily taken it for granted that a city which makes steel must be ugly with grime, that a meat-packing city must expect to be over-spread by a sickening odor, that a coal-mining region is supposed to miss sweetness and light, that if trains operate cheaply and are fast and safe, one must expect them to rattle and shriek, to vibrate and jolt. We engineers need to remind ourselves that an intense preoccupation with utility and economy is characteristic of a pioneer civilization, struggling to acquire its bare necessities and to accumulate capital to get ahead; and that large areas of American life have now passed into a more mature phase of development.

Ethics of Making Money and its Disposition.—In the realm of industrial ethics, we may hope for a changing attitude toward the making of wealth. So great has been our need to accumulate capital in the past that we have been ready to wink at unsocial ways of making money, if only it was later spent or invested to the advantage of society. The industrialist who made his pile by ravishing natural resources, grinding labor, crushing competitors, and enticing investors into a financial labyrinth, then devoted it to building up great enterprises or endowing art, philanthropy and education, has been in our past something of a public hero. His sun is setting. Law and conscience will do well to insist that the process of making money, as well as its disposition, shall directly serve social ends.

Dominant Social Urges.—Epochs in our history have formed and re-formed around a sequence of characteristic social urges—the urge to escape from the limitations of the old world, the urge to attain to self-sufficiency, the urge to expansion, and the urge to multiply goods and wealth. He can best forecast the next two or three decades who can most clearly foresee their dominant urge.

The social urge of one epoch does not die; it merely becomes overshadowed by a new one. The urge to produce is not dying, but it bids fair to be overshadowed by a rising concern to guarantee that the production of wealth shall serve broad social interest and that it shall be widely distributed, not alone as goods and economic security, but also as intangible privileges of leisure, recreation, education, and cultural activity. The era of technological pioneering is far from ended, but we may see our major efforts as a people shifting into the realm of pioneering in social and economic controls. What has the engineer to gain or lose in such a shift of emphasis and what distinctive contribution can he make to a new age?

Molding Influence of Social Changes on the Technical Professions.—The transition decades following the American Revolution called the technical professions into being, and the decade of the 1870's vastly enlarged their scope and opportunities. It was then that engineers began to multiply and to organize along specialized lines, that scientific training got its first firm foot-hold. Schools of technology, of which there had been six up to 1860, increased to sixty-two by 1872. The curriculum was organized into parallel branches, laboratory and shop instruction was widely introduced, and a distinctive American technical literature began to appear.

The engineer of the early decades of the last century had been largely an individual builder of highways, bridges, canals, water wheels, engines, textile machinery and railroads. As a constructor, he was prepared to deal with nature and with men in the rough —a man who came, surveyed, planned, built, and went his way. As a manufacturer, he had no sense of professional caste or code. In either case, he was an intense individualist and a man of independent spirit. In the later decades events tended to curb this individualism and gradually to transform the engineer into a team-worker and an executive. With the consolidation of the railroads, the engineer began to take his place in corporate industry. An individualist might locate and construct a line, but it needed another type of man to weld separate units into an organic system and to plan systematically for its maintenance, betterment and extension. The engineer found himself working with men and money, as well as with materials and machines. In the electrical and chemical industries the engineer took his place as an operating executive as well as a planning and construction specialist from the beginning. As manufacturing, under the influence of Taylor and his disciples, came to be conceived as a completely planned and integrated process based on research, the engineer's function enlarged on the side of management. The intense individualism of earlier years had given place to a more collective philosophy; a growing consciousness of the profession

as a corporate body was in evidence, and engineers began to pride themselves as being the vanguard of a sweeping movement to professionalize the entire direction of industry and of business as well.

Social Function of the Engineer.—The historic rôle of the engineer has been to take guesswork out of construction and production by a blend of science and horse-sense, and to put self-interest in the background under a code of professional ethics and responsibility. The place which he will be able to claim in a changing society will depend on his ability to change with it, to bring new scientific resources to bear and to broaden the area to which he applies his characteristic procedures. For example, the engineer has taken the guesswork out of the mining and cleaning of coal and its conversion into other forms of energy. Can he take guesswork out of opening of new mines, regularizing working time, providing a decent living for workers and insuring the economic use of fuel in its final conversion? He has taken guesswork from the design and manufacture of motor vehicles, but the selling costs remain disproportionate to the costs of production. How much guesswork can be gotten out of their distribution, the cycle of their use and their final disposition? Do the styling changes on which the industry spends its feverish efforts actually stimulate or derange the market, in the light of cold analysis?

Engineering and Industrial Management.—Engineering management aims to remove guesswork from the executive direction of industry. The old corner stone of authority was the word of the boss; the new one is research. The engineer as manager does not trust to tradition, which means the privilege of repeating the mistakes of one's grandfather; instead he seeks to rest decisions on established laws, on verified facts and on tested standards. Do such laws, facts and standards exist as a basis for decisions which touch on human relations? Engineers have been inclined to answer "no" and to lift their eyebrows at the scientific pretensions of the several branches of social study. An open-minded reading of the two-volume report of Mr. Hoover's Commission on Recent Social Trends will give surprising evidence of the extent to which the social sciences have approximated a valid basis for social control. The engineer of tomorrow cannot afford to slight the study of history, economics, sociology and political science, intangible though they may seem. They will not only influence his social philosophy, but his arithmetic as well, through fairly certain changes in the premises on which his valuations, his calculations of annual costs and present worths, his estimates of useful life and earning power, his allowances for obsolescence, and his proposals for quick or long-range exploitations of resources, will rest.

The Engineer a Social Pragmatist.—Increased attention to the

social premises of engineering does not imply that the engineer is to become a propagandist or a revolutionary. By nature and function, the engineer is not a social doctrinaire of any sort. He is a social pragmatist and a believer in evolutionary change—one whose "aim is to test all things and hold fast to that which is good." He will work within any social system, as far as it will work—equally in democratic America, in imperialistic Japan, in fascist Italy, and in communistic Russia. In a changing social order, the engineer will find a healthy pragmatism a valuable asset. The doctrinaire risks the perils of disillusionment or even martyrdom for the possible ecstasies of triumph. The pragmatist has little chance to be acclaimed a prophet, but he can make quick adjustments without violence to his conscience or his personal loyalties. When the dust of revolution settles, he will usually be found at his old job of keeping the show called civilization going.

Should Engineers Assume Social Control?—Because engineers, in their normal business of production, construction, and technical service, will be actively concerned with human relations and social welfare, it does not follow that they will necessarily displace bankers, lawyers, economists, journalists, social workers and politicians in the direction of our common concerns. The engineer has his gifts, but also his limitations. His field of natural leadership is that of factual, analytical, constructive planning and action on material problems. The management of money and men is not his domain by inherent right, but because it cannot be disentangled from his material responsibilities. In a certain sense the engineer's habit of factual, analytical, and constructive thinking is incompatible with philosophical thinking involving conflicts of value and with judicial thinking involving conflicts of human interest. This incompatibility tempts the engineer to disparage generalized thinking and to express impatience with economists who cannot make up their minds. The engineer's scale of social values, I believe, is sound within its limits, but still inadequate for the broader phases of public leadership. While he will be increasingly affected by the so-called social sciences, there is little prospect of their soon attaining to that state of predictive control which would put their practical execution into his hands. Economics, sociology, and government are, in fact, aspects of social psychology and in their practical aspects fully as large scope must be left to sheer insight and sagacity as to any scientific technique.

The contributions of science and technology to the making of our present social structure are great, beyond all calculation, yet I wonder if we engineers do not at times overestimate our part in the planning of the edifice, as if those who quarried the stone, burned the bricks, and fabricated the steel were to claim credit

for the design of the state capitol. We often underesteem the professions of social planning and social regulations, whose techniques are less precise than our own, and because we underesteem them, we fail to coördinate our work with theirs, to our own disadvantage.

The Engineer's Field of Control in Social Enterprises.—As we come now to consider more directly our educational functions and processes, I should like to propose our whole-hearted acceptance of the principle that the control of what Thomas Huxley called "things and their forces" and "men and their ways" belong primarily to distinct groups of professions, but that these functions interweave and interlace in our industrial society. Engineers will continue to deal primarily with things and forces, incidentally with persons and social relations. They will be drawn increasingly into the executive direction of industry wherever the hazards and responsibilities which cannot be delegated and passed on to others rest on technical considerations —that is, where competition is between products rather than firms, where competition centers on economies in production rather than sales promotion, where the risk of being superseded by some new product of research or invention is constant and active, where an intricate technical service must be kept going against all manner of natural hazards, and where the coördination of diverse plants and equipment is of paramount importance. For the present, at least, this is a large enough world for the engineer to conquer, and he need waste no tears of regret if the principal responsibilities of risk bearing, credit administration, legal relations, finance, accounting, sales promotion, and retail merchandising remain for the most part in other hands. The same is true of social amelioration and personal service in all its varied forms, and perhaps of virtually all elective offices as well. Engineers will find ample scope for their contributions to government through the new functional units being recognized and created under the Industrial Recovery Act.

Ethical Sensitivity Needed by Engineers.—Until a better equilibrium is reached between technical control and social control, the safety of society demands a type of leadership in industry which is highly sensitized on the side of social ethics, one that can strike a humane balance between the impersonal long-range aspects of social progress, and the immediate well-being of human individuals. It is the business of the engineering profession to supply the greater part of this leadership. We constitute the dominant professional group within the industrial world, where as yet the professions of social control have scarcely penetrated. Because we are a profession, society has a right to expect of us a

certain disinterestedness of spirit, a devotion to truth wherever it may lead, and a conscious dedication to the good of society as a whole. We are expected to have the long view and not to live merely from one balance sheet to another. We have a tradition of ethical accountability. We stand for the rule of science rather than intuitive guesswork. We are not doctrinaires and revolutionaries, but pragmatists with our feet on firm ground of fact and experience. Like the young man of the Bible who had kept the law from his infancy but who aspired to an even higher moral perfection, some of us may ask "What lack I yet?" The answer, as I sense it, would be a more humane understanding of the immediate results of our work on men as persons.

The Professional Nucleus in Engineering.—At the center and core of our educational program is the recruitment and training of that inner nucleus of professional engineers, an intellectually qualified, scientifically grounded, socially intelligent body of men, bound together by a strong code of ethical responsibility, finding delight in the self-expression which their work affords, avowing a conscious ideal of disinterested service, and having a perspective that sees beyond the immediate reaches of expediency into the wider areas of social welfare. Immediately about this inner nucleus is an even larger group to be trained for the technical direction of industry, no less engineers than their more purely professional brethren and sharing their ideals, though with accommodation to the expediency of the hour and the situation. In a more outlying zone are men who will find their way into callings and professions not directly related to engineering, where they may contribute significantly to the interweaving and interlacing of the two great functions of technical and social control.

Engineering Education now a Qualitative Problem.—For a time, at least, the forces of expansion in American life, if not actually spent, are likely to be retarded. We have had our day for the spread of engineering colleges, the multiplication of courses, the mounting of enrollments. Our problem has now become qualitative, rather than quantitative; selective, rather than expansive. Whatever else engineers may be, they are executors for the more exact sciences. This, I believe, supplies the key to the selective process. We have no concern with young men who lack either the ability, the interest, or the preparation to master a group of sciences basic to engineering. I emphasize the word *master* by way of contrast with the growing vogue of orientation courses in the liberal colleges. I believe we shall teach more science rather than less, and teach it more profoundly, but it will not be metaphysical or speculative science. A career in engi-

neering and industry is largely a career of decision and action, action that is carefully planned in advance, carefully controlled for economical use of money and effort, and carefully criticized to discover every chance for improvement. We shall select and train men of action. We shall teach them the art of applying accurate knowledge to the world's work. We shall give every man abundant opportunity to discover his own life interest by his activities, and in doing so to taste the joys of mastery and achievement. I submit that this is good education, and that we can well afford to stake our claims for recognition on the quality rather than the volume of our work. I am flatly opposed to taking in all comers and trying to do them some good. Let us welcome other institutions which have this objective into the larger educational family, but leave the task of assimilating and adjusting the great body of unselected students to them.

The Social Sciences in Engineering Education.—I have indicated my belief that the engineer must reckon more largely with the social sciences and that they must have a more generous place in our teaching. May I add the belief that they should be taught by men whose major interest is in human beings and society and not by engineers. Our students need to know the controversial nature of these subjects and the conflicts of human interests which they involve. They need an organic conception of society and some perspective of its evolutionary character to save them from thinking the existing social organization as being final, static, and inevitable. They need to know the limitations of all social controls, and most of all to be saved from the most dangerous of all forms of ignorance—that naïve innocence which tempts the tyro to rush in where experts fear to tread. But social studies for the engineer are not mere cultural veneer; they need to be tied functionally to his sphere of work, and this aspect of the problem is still largely unsolved. Proper functional adjustment of the teaching of language we have largely achieved and I can think of no more promising means of reaching a similar objective in the social studies than to tie their teachers more closely to this Society, which has been the great integrator of engineering education in America.

Post-Graduate Technical Specialization.—If we do full justice to the basic sciences, to language and literature and to social studies in the undergraduate curriculum we shall have less time than we are now devoting to technical applications. Inevitably these will pass in larger degree to the realm of post-graduate training and in the process acquire a more profound, more individualized and more investigative character. The element of discipline will grow less, the element of discipleship more. Teachers of higher application will, of necessity, be creative authorities in their own right and not umpires between the student and the textbook.

An Organic Conception Needed in Training Engineers.—Our concern as educators, facing a new epoch in the making, is not so much to make our graduates more proficient in details, whether of technique or of management; it is to develop men who are able to deal in a more statesmanlike manner with the major economic and social problems within their normal areas of responsibility. As the speaker sees it, the solution of this problem involves more than adding this or that to the curriculum or keeping boys a year or two longer in college under the guidance of subject matter specialists. It involves a more organic conception of the whole process of recruitment, training, and development within the technical professions, one that transcends all details of the traditional or accidental divisions of schooling and apprenticeship, the regulations of licensing boards and the rules of eligibility for the successive grades of membership in the professional societies.

It is encouraging to note that the newly formed Engineers' Council for Professional Development is contemplating no less than a scheme of educational guidance that reaches down into the secondary school, bridges the college period, and covers the early years of professional activity, and which envisages some comprehensive appraisal of educational attainment at a mature level, as a qualifying standard for certification into the profession.

An Intellectual and Ethical Ideal for the Engineering Profession.—Many educators hope that this broader view, with its increased emphasis on further education after college, may so relieve the pressure on the undergraduate curriculum that a more profound grounding may be given in both the scientific and the societal groups of studies. Replacing these necessary foundations with elementary management subjects will not solve the problem of a more adequate professional preparation. The study of management, undertaken at a reasonably mature level, may supplement the scientific discipline in a very valuable way and is a legitimate adjunct of the technical instruction of an engineering college, but if we are to remain a profession in both the individual and the corporate sense and not become merely a fraternity of managers and executives, we must maintain at all hazards the primacy of the exact sciences and of the philosophy of social institutions and responsibilities. Society will choose its leaders from every calling, and we may confidently hope that the engineering group will supply an even more generous share than in the past, but if we turn aside from the training of men who are specially qualified to direct the great sources of power and the treasures of nature's storehouse to the service of man, with an enlightened scale of social values and under an austere code of professional integrity and duty, we do so at the peril of our civilization.

SOME IMPLICATIONS OF THE JUNIOR COLLEGE MOVEMENT *

By GEORGE F. ZOOK

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It is said that the best definition of tradition is accumulated experience. Hence it seems as if, at the present time, we have in our various social organizations, including the educational system, a heritage of accumulated experience and wisdom that ought to exceed in quality and effectiveness anything that has gone before. It is natural, therefore, for social leaders, including those who are engaged in educational work, to emphasize the virtues of things as they are, or have been, with certain implications that things as they may be will not be so worthy or effective.

It is well for all of us to realize, however, that both physical and social life are processes of growth and development. We are constantly evolving from one condition of social existence into another. The educational system, indeed, is forever being beaten upon by other complex and conflicting—but nevertheless powerful—currents of social life that affect both the direction and organization of education.

At the present time we seem to be in the midst of one of those eras where social changes are coming with increasing rapidity. What their ultimate effect on the present organization of education will be or, to put it another way, how well education will adapt itself to the new era we seem to be entering, are matters about which, at the present time, we can do little more than conjecture.

In education, however, as in all aspects of life, those who are in positions of responsibility are called upon to discern the future by making up their minds to what extent that which has been found worthy in the past will prove to be equally successful in the future. With one hand we must hold fast to tradition in education while with the other we should attempt sympathetically but courageously to select out of a host of promising panaceas those new ideas and practices which will actually help to solve the problems of the new day.

Among the comparatively new ideas in educational organiza-

* A paper written for the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 6, 1933.

tion today, few are mentioned more frequently than the so-called junior college movement. By its very nature it strikes rather directly at the present organization of all four-year curricula above high school grade and on account of its increasing popularity in many states in the Union, it bids fair to make a deep impression upon the future of all under-graduate institutions, including the colleges of engineering.

To understand the movement, one must get at some of the underlying factors. I shall discuss but two of them. The first of these is the simple fact that through the establishment of junior college facilities in increasing numbers throughout the country, a larger and larger proportion of the population is able to secure the advantages of two years of education beyond the high school at a minimum of cost. Every study that has been made of the situation shows clearly that when such facilities are available to the people of a community they will avail themselves of such opportunities in considerably larger proportions than they do when it is necessary to go away from home to college. In this respect the junior college is repeating the experience of local high schools at the time of their expansion. The very large number of post-graduate students in public high schools, even where college facilities are available locally but only upon the payment of a fairly high tuition rate, is another evidence of the necessity and good sense of providing educational facilities beyond the high school to students who must or who prefer to live at home while attending college. The rapidly increasing thousands of students who are availing themselves of junior college facilities in such states as California, Michigan, Minnesota and Texas are eloquent evidence that the basic trend can not be denied though it may be badly in need of guidance.

The second consideration is educational. Historically the elementary school and the college in this country were founded about contemporaneously. The secondary school came later and, only after the pattern of the elementary school, tended to reach upward in years and to some extent in curriculum, and after the college had reached downward to include in its curriculum many subjects which were so general and elementary as not to belong properly to the field of higher education. Under these circumstances the secondary school, which was later inserted between these two crystallizing units of education, found itself occupying a restricted and uncertain area of four years of education. To find itself as it has done in Europe, it has been compelled to elbow the elementary school on the one hand and the undergraduate college on the other. In many school systems it has seized the latter two years of the eight-year elementary school and has organized

a new unit known as the junior high school. In somewhat the same way it is reaching for the first two years in college. Should it be successful, there may ultimately be an entirely new organization of the units that comprise the general and secondary part of our educational system.

In order that I may set forth briefly the function of the junior college as a part of the proposed revised secondary school system, I can do no better than to quote briefly from the report of the Commission which, about a year ago, made a study of public education beyond high school grade in the state of California:

"It is only because junior college work historically was merely the first two years of a standard four-year college course, as it still is in many instances, that it is popularly regarded as part of higher or university education. In most four-year colleges, the point of articulation between the first two and the last two college years is so marked, that functionally they should be regarded as substantially different. One terminates general education; the other begins concentration or specialization. Their close association in the same institution under a single administration with no degree or title marking the close of education below the true university level, a degree being given only on the basis of a four-year study, is the obvious fact which confuses the laymen and conceals the one outstanding point, where secondary and higher education join, and where education changes its function more markedly than at any other point in a student's continuous progress through the school system. It must be remembered that education is a continuous process. If yearly and other administrative units are artificial, then institutional units embracing several years may be equally artificial.

"In this case the transfer from the basic and wider social education of common schooling to the specialized education of university curricula occurs midway in the traditional four-year college. Traditional institutional forms and organizations thus persist after functions change. The esssential fact of change of function is recognized by the California law dealing with junior colleges and by the granting of the junior certificate by the University of California at the end of the second college year. The public, parents and students in particular—should be made fully cognizant of the fact that general education, liberal and social in its main intent, really completes its school provisions at the end of the junior college."

This analysis of the situation facing the educational system at the conclusion of the present four-year high school led the California Commission to recognize five fairly distinctive fields in which the junior college should operate as follows:

1. The first two years of the regulation four-year curriculum in Liberal Arts and Sciences. This is the type of curriculum found in almost all junior colleges in the present state of development.

2. The preprofessional field for entrance into professional schools such as medicine and law which have made two years of college work a prerequisite for admission.

3. A two-year course of study frankly intended as the completion of the general secondary period of education in which the facts of the physical and social world about the individual are synthesized with the purpose of aiding the student to an appreciation of the significance of these things in modern life. Such a situation is seldom found at present but it bids fair to occupy an increasing importance in the future. The question is even raised whether, taking the total experience of the student into consideration, such a course of study would not be better for the prospective professional student than the present preprofessional curriculum and also whether it would not be of more assistance to the general scholar who wished to continue his education than the first two years of the present Liberal Arts college.

4. The semi-professional field comprising one and two year curricula for the preparation of young people in the middle positions, below professional grade but above the vocational. The S. P. E. E. performed an excellent task in its report a year or so ago, describing the wide range and the large number of positions which fall with this category. On the other hand it greatly underestimated the possibilities of the junior colleges as against the so-called technical institutes in meeting this need.

5. Promotion of the field of adult education. Several of the California junior colleges, including particularly the one at San Bernardino, have rendered noteworthy service in this growing field of work.

I have given this part of this discussion a considerable part of the time assigned to me in order to bring out as clearly as possible the comprehensive character of the junior college movement. It is not a policy applying to any single group of the students who complete the present four-year high school but a comprehensive philosophy concerning the respective policies which ought to be pursued in the education of all young people who go beyond the present high school period.

When, therefore, one takes into account, on the one hand, the urge which is being given to the movement by educators, and on the other, the tendency for students to flock to the colleges in rapidly increasing numbers, it seems clear to me that we have with us a great educational force which must be reckoned with in the development of all units of education beyond the high school.

All history teaches us that social movements are often initiated and developed by those who *feel* as well as those who *know*. Hence the earlier stages of any educational movement, no matter how significant it may later prove to be, are hazy. Its outline is not clear, its direction is not certain, and it is likely to be seized upon by well-intentioned friends who are too little concerned about maintaining the quality of its performance and organization.

I wish therefore to suggest some ways of guiding this movement which, I believe, is bound to continue its rather phenomenal growth.

First, the junior colleges should be organized into sufficiently large units as to be both effective and economical. I have recently had an opportunity to canvass the situation in higher education in Iowa. There, among other things, I found 27 junior colleges, only 3 of which enrolled more than 100 students. The median for the entire group was only 60. It is universally agreed among those who have studied the development of junior colleges that a unit of this size is entirely too small to be effective. All those, therefore, who are interested in the preservation of educational standards and in the conduct of work on an economical basis should join in securing legislation which will avoid the repetition of instances of this character.

More especially what this means for the engineering colleges is that proper facilities and faculty should be available for instruction in the sciences and mathematics which are basic to engineering. In a large proportion of the small junior colleges of the country, adequate facilities of this nature do not now obtain. Obviously in the interest of many major divisions in higher education, including engineering, this situation should be corrected.

Wherever it has been corrected there seems no good reason why the junior colleges may not conduct the first two years of the undergraduate curricula, including freshman and sophomore work in engineering, on an entirely satisfactory basis. The experience of the University of Michigan with the work of the junior colleges in Michigan along this line has, I understand, been very reassuring.

Junior college units should not only be large enough to be conducted economically but in a considerable proportion of them they should be large enough so that they may perform a comprehensive task. In the junior college at Los Angeles, California, one has an illustration of a junior college which realizes the importance of semi-professional curricula of completion nature. As situations of this character become more clearly identified and as the regular school system more definitely recognizes its responsibilities for vocational training, we may expect a larger amount of and more effective training along semi-professional lines.

If the junior colleges are to be recognized as the completion of general secondary education, they should be more closely integrated with the secondary school system. Both tradition and the regulations of the accrediting agencies have slowed up a process which is now definitely under way but which, so far, has not made a great deal of progress. Experiments now under way at Kansas City, Mo., Pasadena, California, and at the University of Chicago demonstrate the possibilities of greater effectiveness in the processes of education through the better integration of two educational units hitherto arbitrarily separated. Another important object in the closer integration of high school and junior college work is to eliminate what now appears to be a considerable waste of the students' time in the repetition and duplication of work between the high schools and the first two years of the undergraduate college.

It seems very clear, therefore, that before junior colleges can actually fulfill the hopes and expectations of their friends it will be necessary for them in many instances to secure more adequate financial support, better teachers, and more satisfactory facilities and so to organize themselves that they may uniformly be conducted on an economical basis with proper attention to the several distinctive lines of work which fall in this field.

At the same time it may also prove necessary and desirable for a major field in higher education such as engineering, with one hundred years of very significant history behind it, at least to modify its future course of development. Personally I believe that this modification, instead of causing injury to, will greatly benefit the whole field of engineering education.

In support of this statement may I allude to an article which I wrote several years ago in reply to an alarm sounded by the late Professor George Herbert Palmer in the *Atlantic Monthly* entitled "The Junior College." At that time I endeavored to show some of the benefits which would accrue to the four-year undergraduate colleges of the country through the development of junior colleges. Among these was the likelihood that through the transfer of junior college graduates to the four-year colleges the number and proportion of upperclassmen as against freshmen and sophomores in these institutions would increase. The result would be gradually to elevate the emphasis of these institutions more largely to advanced work to the great satisfaction of the faculty and others concerned with the development of these institutions. This very thing has been happening, though of course it is not due entirely to the junior college movement. In Iowa, Kansas, Minnesota, and Michigan the proportion of upperclassmen to underclassmen in the

state universities has in late years gradually increased. The same situation has obtained in the privately controlled colleges of Iowa, and probably in similar institutions elsewhere. To whatever extent the junior colleges contribute to this situation the four-year undergraduate colleges are obviously the beneficiaries.

Conversely, the junior colleges relieved the four-year colleges, including the engineering colleges, from the time consuming and onerous task of sifting students during the first two years of the undergraduate curriculum. A comprehensive piece of work along this line has been done by the junior colleges of California with considerable success. In other states the natural processes of selection have operated to the same end. As a result, while the graduates of the junior colleges have sometimes been deficient in specific preparation, they compare well with other students in native ability. The four-year undergraduate college, including those in engineering, should be grateful for this assistance in a day when we are still struggling with the problems of mass education.

I wish, furthermore, to call attention to the fact that all the scientific studies which have been made relative to the admission of students to college seem to show clearly that specific preparation and prescribed high school units play a far less important rôle in later success in college than we used to suppose. Native ability and special aptitude seem to be the chief determining factors. While probably the same proofs have not been made concerning the later significance of specific preparation in the first two years of the undergraduate curriculum, still it seems fair to assume that the results may be much the same. If, therefore, we plan to conduct engineering schools on the most effective basis, it will be necessary for us not necessarily to emphasize less the value of specific preparation but rather to provide ways and means of identifying as early as possible those who seem fitted for an engineering career and then to adapt the facilities of the institution to suit their respective needs. This provision is a part of the larger personnel movement which bids fair to revise very radically our whole treatment of the individual student.

In this brief discussion I have been able to touch on only a few of the more significant implications of the junior college movement. It is an infant in the educational world but it looks like a lusty one bound to grow. Whether it only adds confusion to our times, like a child with his toys in a playroom, or grows up into a very useful citizen, largely depends on those older and more experienced educators who can, if they will, guide its course of development. As yet the quality of its performance is not assured but it

has demonstrated that it can do satisfactory work. In some states it has been allowed to spring up like a mushroom in any community, large or small, without adequate sustenance and with little promise of reaching a satisfactory maturity. On the other hand it is popular with its constituents because it is both democratic and easily accessible geographically and financially. It ought to adapt itself to the needs of its associates both young and old in the educational work but as is always true in a family, the old folks may also be called on to adjust themselves a bit to the careers which the young people largely carve out for themselves.

THE PROBLEM OF ACCREDITING ENGINEERING COLLEGES *

By H. P. HAMMOND,

Professor of Civil Engineering, Polytechnic Institute of Brooklyn, *Director,* Summer School for Engineering Teachers, Society for the Promotion of Engineering Education.

Whatever our views as to the desirability of accrediting may be, we must recognize it as a condition to be dealt with and not merely as a theory. Accrediting of engineering colleges we already have with us, whether we approve of it or not. Engineering colleges are not only now recognized or approved by educational agencies—the several regional associations, associations of universities and colleges, and the like—but they are also recognized or approved by the profession through the national engineering societies and for legal purposes in many states by the state engineering licensing boards.

Our present problem, therefore, is not to determine whether there shall be accrediting, but whether the schools themselves, either individually or through this Society as their common agency, or through its membership, in turn, in some other representative agency, shall participate in determining the methods and procedures and the standards in accordance with which they shall be accredited.

This brief paper accepts the above statement as a premise and therefore makes no argument for or against accrediting. It is devoted, instead, after presenting some facts concerning accrediting methods now employed in our own and other fields, essentially, to a statement concerning the steps being suggested or taken by your present representatives who are attempting to deal with the problem.

Accrediting of colleges is by no means a recent development. Medical schools have been accredited and classified since 1906. Regional and other educational associations have either virtually or officially accredited colleges for a longer period. In our own field, the American Institute of Chemical Engineers has been accrediting for more than ten years and the American Society of

* An address delivered at the Conference of Administrative Officers of Engineering Colleges, Madison, Wisconsin, July 7, 1933.

Civil Engineers has maintained a list of "approved" colleges for as long a period, to mention only two illustrations.

Several types of organizations are concerned with accrediting. The following list may not be complete, but it is indicative of types. It will be noted that engineering schools are accredited, directly or indirectly, by several of these organizations.

(1) Regional educational associations, one of whose prime functions is the accrediting of schools and colleges, such as the North Central Association of Colleges and Secondary Schools, The Association of Colleges and Secondary Schools of the Middle States and Maryland, and the Southern Association of Colleges and Secondary Schools. These associations now cover most, if not all, of the country. Engineering schools are accredited by these associations—not, however, primarily as professional schools, but merely as institutions of higher learning.

(2) National educational associations, such as the American Council on Education, which maintains a list of institutions which it recognizes, the Association of American Universities, and the like. These groups also recognize engineering colleges as institutions of higher learning, but not, essentially, on their specific qualifications as professional schools.

(3) Groups or associations of professional schools. This is a large and influential group of associations whose accrediting procedures have had far reaching effects in education for the profession. The Association of American Medical Colleges, of Law Schools, of Schools of Pharmacy, of Architecture, or Business, of Journalism, of Social Work, etc., are groups of this type. Engineering is not represented, as to accrediting, in these groups.

(4) Professional associations, some of them of legal or quasi-legal status, such as the American Medical Association, the American Bar Association, etc. It was the work of the A. M. A. and the Association of American Medical Colleges in accrediting schools of medicine that undoubtedly gave the greatest impetus to accrediting throughout the whole realm of education for the professions.

Engineering is represented in this group by the National Societies, such as the A. I. Ch. E., the A. S. C. E., and others that maintain or publish lists of approved colleges for various reasons: evaluation of membership qualifications, establishment of student chapters and branches, upgrading educational standards, etc.

(5) Governmental agencies having to do with professional licensure, such as in medicine and law. Engineering here is affected directly by the State Boards of Engineering Examiners, whose National Association has been engaged in preparing uniform standards of accrediting for the past two or three years.

Thus far the federal government has taken no part, directly or indirectly, in accrediting except, of course, in relation to institutions receiving federal aid.

Methods and bases of accrediting by the above agencies differ quite widely, ranging all the way from the preparation of a list of "approved" institutions virtually on the say-so of one individual to adherence to very closely prescribed standards. In the case of several of the agencies enumerated above, particularly the associations of professional schools, accrediting is done by accepting for or refusing admission to the association on the part of colleges that do or do not comply with certain prescribed "minimum qualifying standards." In other cases accrediting is done merely by the publication of a list of acceptable institutions. In some few instances such lists exist but are not published.

Factors considered in accrediting also differ widely. Some agencies specify quite rigidly almost everything pertaining to the work of the institution:

Organization and support
Curriculum
Admission methods and requirements
Physical plant
Library
Teaching staff
Finances
Etc.

Others maintain only very loose prescriptions.

Procedures in connection with the machinery of accrediting also differ considerably, but almost all agencies collect information from publications and by means of questionnaires, more or less elaborate (generally more), and many evaluate in part at least through visits of inspection. One or two associations emphasize the careers of graduates in graduate schools, such as the Association of American Universities.

By piecing together bits of information in the foregoing paragraphs the present status of accrediting engineering schools may be outlined. To summarize:

Engineering colleges are now accredited, but simply as insti-

tutions of higher learning and not on the basis of qualifications as professional schools, by the several regional and national associations that have to do primarily with accrediting. They are recognized as "approved" institutions for purposes of evaluating membership qualifications and for other purposes by the National Engineering Societies. This is accrediting in a rather loose sense. In one instance, however, *i.e.*, chemical engineering, accrediting is in accordance with quite definitely stated procedures and specifications. Furthermore, the A. I. Ch. E. keeps tab on institutions it has accredited and re-visits them at intervals. Third, and finally, the State Licensing Boards accredit or recognize schools in a very real way, and it is right in that connection that the problem of accrediting is before us in its most important and serious aspects and where it has the greatest potentialities for good or for harm.

It is undoubtedly fortunate for the schools and for the profession at large that just at the time when accrediting was beginning to be done systematically by the State Licensing Boards, there came into existence a joint agency representing the three groups having a direct interest in this problem: the schools and colleges of engineering, through the S. P. E. E.; the organized body of professional engineers, through the five principal national engineering societies; and the public agencies, through the National Council of State Boards of Engineering Examiners. I refer, of course, to the Engineers' Council for Professional Development.

This agency whose organization was ratified by our own Society at this time last year, has appointed a committee known as the Committee on Engineering Colleges, whose purpose, among others, is "to formulate criteria for colleges of engineering which will insure to their graduates a sound educational background for practicing the engineering profession." In simpler words, this means to formulate a basis for the accrediting of engineering colleges.

Several direct and practical benefits may be expected to issue from the accrediting of colleges by this agency:

(1) A single, uniform standard and system will replace the present heterogeneous standards in effect.

(2) All parties of interest will have representation and a voice in formulating those standards and in carrying them into effect. This is of really fundamental importance. We, the colleges, now have a voice in that which concerns us and which promises vitally to effect us in the future. The fear of outside dictation and of imposed standardization that might tend to hamper and restrict rather than to elevate and strengthen, is largely removed.

(3) The accrediting agency is given the benefit of our knowledge and experience in this matter and it is reasonable to believe that standards and procedures can and will be improved accordingly.

(4) By no means an unimportant advantage of accrediting by one joint agency is the avoidance of needless duplication of labor all around—to be specific, the filling out of a single questionnaire from one central source, rather than several, from different sources. There will also be a saving of expense when visits of inspection are involved.

The Committee just mentioned was completed early last winter and has functioned effectively since then. It has studied accrediting procedures in other divisions of higher education. It has studied accrediting procedures now in effect with relation to engineering education itself. It has drafted a proposed basis of accrediting which it is now submitting to the Council proper for comment and criticism and, we hope, for adoption by the constituent organizations as the basis for accrediting that will, thereafter, be employed by all of those organizations. The Committee, further, has drafted the forms required to secure information and is suggesting the establishment of a central agency, or staff, for carrying on the details of the work.

Concerning the specific details of the basis of accrediting that is being recommended to the Council, we can say little at the present moment, since they have not as yet been formally adopted. Time, incidentally, will be required to have them adopted by all seven of the groups represented in the Council. We may, however, say this much as to our recommendations: We hope that some of the errors learned from experience in earlier accrediting plans have been avoided. In particular, we hope and believe that we have avoided the mistake of detailed specifications, rigid adherence to which constitutes that imposed standardization that has become the all too common result of accrediting in some fields. We recommend criteria based fully as much upon quality of work and of results as upon details of admission and curricular requirements, though the latter will be considered. Minimum standards in these latter are, of necessity, included in the basis of accrediting recommended. Accrediting will be on the basis of individual curricula and both undergraduates and graduate curricula will be included eventually, though undergraduate curricula will be dealt with first. A minimum of factual information will be secured by means of questionnaires in comparison with some such questionnaires as have been circulated in recent years. It is expected in the case of institutions and their curricula which

cannot be accepted without question, that visits of inspection by persons competent to inspect will supplement the gathering and interpretation of statistical data.

No attempt will be made to classify schools in groups according to rank or order of excellence, such as obtained in Medical education at one time; the purpose will merely be to designate those institutions that are worthy of recognition as professional schools of engineering.

Finally, the committee considers its function in relation to engineering colleges not to be limited solely to accrediting. It hopes to be of constructive helpfulness to the colleges and to form one more tie between the schools and the profession they serve.

The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FREDERIC G. HIGBEE, EDITOR

Plans for the Year: As a result of meetings and conferences during the annual meeting of the society, the Division of Engineering Drawing already has begun work on the following important projects:

1. The preparation of biographical material for engineering drawing departments setting forth the important part drawing renders in engineering service as expressed by noted engineers;
2. The collection, for exhibition at the next meeting of the society, of old works on descriptive geometry. Professor F. M. Porter, University of Illinois, has been appointed chairman of the committee to collect this historic material;
3. The collection and suitable storing for future generations of all types and kinds of drawings. Professor Wm. G. Smith of Northwestern, who has been selected for this task, is not only authorized for the division to gather such valuable records of early drawing as may still be found but also to find a central place where such valuable and interesting historic material may be permanently housed and preserved;
4. The collection, for display at the next meeting of the society, of drawing instruments both ancient and modern. Professor F. W. Ming of the Brooklyn Polytechnic Institute, has consented to serve as chairman of the committee in charge;
5. Collaboration with the Committee on English for the development of standards for an annual competition and exhibit of Engineering Reports. Professors Thomas E. French and F. G. Higbee represent the division.

Members of the drawing division are urged to coöperate with these committees. Information concerning probable sources of the material which is desired should be forwarded at once to the committee chairman in charge of each project. No doubt many drawing teachers will have valuable suggestions and ideas to offer and coöperation will be welcomed.

Members are also invited and urged to forward suggestions and ideas on matters of interest to the division to Professor H. M. McCully who was reelected Chairman of the division at the Chicago meeting.

COLLEGE NOTES

Massachusetts Institute of Technology.—A number of significant changes have taken place on the Technology faculty due to promotions, retirements, and deaths. Professor Edward F. Miller, for 47 years a member of the staff and since 1911 head of the Department of Mechanical Engineering, died in June. His place is to be filled by Dr. Jerome C. Hunsaker, formerly of the United States Navy and later vice-president of the Goodyear Zeppelin Corporation. Dr. Warren K. Lewis has been appointed acting head of the Course in Chemical Engineering, a position left vacant by the untimely death of Professor William P. Ryan.

In addition to the retirements of Dr. Davis R. Dewey, head of the Department of Economics, and Dr. Waldemar Lindgren, head of the Department of Geology, with the title of professor emeritus, Professor William Hovgaard, professor of naval design and construction, Professor Robert P. Bigelow of the Biology Department, and Professor W. A. Johnston, of the Department of Mechanical Engineering, retired with the title of professor emeritus. Four members of the staff of the Department of Architecture whose retirement was announced early this summer are Professors William F. Brown, John O. Sumner, Ervin Kenison and Dr. Charles H. Walker, lecturer on architecture at the institute since 1884.

Professor Hervey W. Shimer has been appointed acting head of the Department of Geology; Professor Ralph E. Freeman acting head of the Department of Economics; Commander Henry E. Rossell, (C.C.), U.S.N., succeeds Professor Hovgaard as head of the Course in Naval Construction. Professor Charles B. Breed, has been appointed acting head of the Department of Civil Engineering in the absence of Professor Charles Spofford, who has a year's leave of absence. New appointments include Professor Lawrence B. Anderson, who comes from the University of Minnesota to teach architectural design. He succeeds Professor Jacques Carlu, who has resigned to return to France, where he is director of the Fontainebleau School of Fine Arts.

This year the Institute is making available to all undergraduate students two new courses: one dealing with industrial and business management, and the other concerned with the architectural phase of city planning.

The former, which will be given in the Department of Business and Engineering Administration, is rather unique in its field.

Covering such subjects as production, marketing, finance, accounting, and business law, the course is designed to give the student an insight into the operation and organization of industrial plants, especially those manufacturing technical products. It will include methods of organization, the beginning of manufacturing operations, and expansion as the business grows, so that students in all branches of engineering may gain a better understanding of the broader aspects of management.

The Department of Architecture will offer this year a new comprehensive course in city planning, which will be in charge of Professor Frederick J. Adams. Sir Raymond Unwin, noted British authority on city planning, will be one of a group of distinguished lecturers. Others will include Thomas Adams, former general director of the Regional plan of New York; Robert D. Kohn and Clarence Stein, housing experts; John Nolen, well-known city planner, and Robert Whitten, authority on thoroughfare planning and zoning.

A further development of the Institute's notable work in this increasingly important field, the course will deal with the design of safer, healthier and more beautiful communities, and the elimination of evils brought on by uncontrolled city expansion.

Further recognition of the increasing importance of post-graduate work is seen in the opening this fall of Technology's first graduate dormitory unit. Dr. Avery A. Ashdown, instructor in the Department of Chemistry, has been appointed faculty house master, and will be assisted in his administrative duties by a student committee.

Three undergraduate houses, Crafts, Nichols, and Holman, have been redecorated and equipped with new furniture and draperies, and now for the first time are being made available to advanced students. Of these, Crafts, which was originally planned as a fraternity house, offers special facilities for the comfort of its occupants, including a large lounge and well-stocked library.

The graduate housing plan was established last spring in the hope of stimulating valuable social contacts among men of differing interests but equivalent intellectual outlook. The immediate response to the plan has been to fill the houses to capacity, with a long waiting list of applicants.

Northeastern University.—Dean Carl S. Ell has announced the following promotions effective in September, 1933: Charles W. Havice from Assistant Professor to Associate Professor of Sociology and Chairman of the Department, Norris W. Potter, Jr., from Instructor to Assistant Professor of English, and Roger S. Hamilton from Instructor to Assistant Professor of Economics.

Two graduate assistants have been appointed in the Day Di-

vision for the coming school year, Alexander F. Sherys, B.Ch.E., and Rudolph Morris, B.B.A., both of whom were graduated with high honor from Northeastern University in 1932. They will serve as instructional assistants in the office of the Dean of Students. Both men will carry on graduate work in the School of Education at Boston University in accordance with a plan of teacher training worked out last year by Dean Ell and Dean Wilde.

Mr. DeLano G. Rice, who has served for the past three years as coördinator for business students, is withdrawing from the faculty this fall to go into business in Vermont, and Mr. Laurence Cleveland, for the past three years a member of the Drawing Department, is leaving to take up graduate work at M. I. T. With these two exceptions the faculty of the Day Division remains intact.

Although business conditions have materially improved, making possible an increased percentage of coöperative placement, there are still a number of students for whom working assignments cannot be found. Therefore, it is planned to continue the series of optional, full time, liberal courses instituted early in the depression. That these full time courses are distinctly worth while is evidenced by the continued interest and enthusiasm shown by the students enrolled in them. Courses to be offered during the current school year are as follows: The Development of Scientific Thought (1600–1875), Introduction to Geology, Problems of Philosophy, Social Psychology, Shakespeare, Modern Educational Theories and Practices.

Varsity football makes its appearance for the first time at Northeastern this fall. To care for an increased number of spectators ten sections of stadium seats have been erected at Huntington Field, seating about 2,000 people. A number of coöperative students were employed in the erection of these stands during the summer months.

An interesting series of non-technical lectures has been planned for the Day Division this year at which the following speakers will address the student body:

The Honorable William E. Borah, United States Senator from Idaho.

The Honorable Robert Lincoln O'Brien, Chairman of the United States Tariff Commission.

Mr. David Seabury, Lecturer.

Dr. G. Bromley Oxnam, President of DePauw University.

The Reverend Bernard C. Clausen, Minister of the First Baptist Church of Syracuse, New York.

The Honorable George H. Moses, Ex-senator from New Hampshire.
Dr. Henry H. Tweedy, Yale Divinity School.
Rabbi Harry Levi, of the Temple Israel, Boston.

A new experiment is being undertaken by the Northeastern Student Union in connection with the orientation of freshmen this fall. The Union is conducting a recreational program at a camp on Lake Massapoag in Dunstable, Massachusetts, for the last two days of the orientation period. Although this portion of the orientation period is optional, a large number of freshmen, particularly those from out of town, are expected to be in attendance at this Freshman Camp. Water sports, a faculty-freshman ball game, short speeches by faculty members, and an evening council around a big bonfire will be features of the program. If the experiment is successful in establishing friendly working relationships among the new students, upper-classmen, and the faculty it will likely be made a permanent part of orientation week.

SECTIONS AND BRANCHES

The 1933 Spring Meeting of the **Middle Atlantic Section** was held at the University of Delaware, Newark, Delaware, on Saturday, May 6.

The program was as follows:

9:00 A.M. Registration, The Lounge, Old College.
9:45 A.M. Inspection Trips:
(*a*) National Orchid Show. Longwood Gardens, near Kennett Square, Penna., home of Mr. and Mrs. P. S. du Pont.
(*b*) Bellanca Aircraft Corporation, airport and airplane factory, near New Castle, Delaware.
12:30 P.M. Luncheon, Old College Commons. One hundred and thirty-two in attendance.

The business session, held in Wolf Hall, was called to order at two P.M. by Chairman Cullimore, who first introduced Dr. W. O. Sypherd, Professor of English, University of Delaware, who extended a welcome on behalf of the University and sketched briefly the past history of the University of Delaware, with particular reference to the growth of the Engineering School.

The minutes of the 1932 Annual Meeting held at Newark, New Jersey, were read and approved, as was the report of the Treasurer. The Treasurer was authorized to ask the membership of the section for informal dues of $1.00, none having been collected for three years.

The following papers were presented:

(*a*) "The Engineer's Duty in an Economic World," in which Dr. J. S. Gould, Professor of Economics, University of Delaware, showed briefly and interestingly the change that has taken place in the engineering profession from ancient to modern times, and pointed out the responsibility of the profession which does not cover merely the art of producing goods, but continues on to embrace the welfare of the consumers of those goods.

(*b*) "The Humanities in Engineering Education," by Hale Sutherland, Professor of Civil Engineering, Lehigh University. This paper set forth the desirability and necessity of including in the engineering curriculum a group of humanistic subjects extending over the four years, which are to be regarded as integral elements in that curriculum.

(*c*) "Selling Engineering," by E. W. Loomis, Middle Atlantic District Manager, Westinghouse Electric and Manufacturing Company. This paper brought to the attention of the meeting an outline of industrial marketing and the essence of good salesmanship.

Following the presentation of these papers there was an interesting and spirited discussion.

The meeting adjourned, after which there was time for the inspection of the laboratories and buildings on the campus.

An excellent dinner was served in Kent Dining Hall, a part of the Women's College, at six o'clock. Service and music were provided most acceptably by certain women undergraduates.

Chairman Cullimore introduced President Hullihen of the University of Delaware, who urged the five-year curriculum for the undergraduate engineering course. President Harvey N. Davis of Stevens Institute of Technology was next introduced, and he spoke in favor of a fifth year of concentrated technical work for all four-year-course graduates indicating their intention of going into research, design or other technical engineering work. Mr. Harry W. Nock, of the Personnel Department of the E. I. du Pont de Nemours & Company, gave a most illuminating address on "Human Engineering," in which he cited the principal requisites for success in the engineering profession.

The secretary was instructed to send a letter of thanks to our host institution and to the speakers who contributed so greatly to the success of the occasion.

The meeting adjourned at 8:05 P.M.

On May 13th, the **Newark College of Engineering Branch** met at the New Jersey Automobile Club Restaurant for a luncheon meeting.

The Branch had planned to have Dr. Alexander, President of the New College for Training Teachers in Teachers College of Columbia University, address them on the "Professional Education of Teachers." Unfortunately, Dr. Alexander could not attend, but the Branch had the pleasure of hearing Dr. John S. Gambs, an associate of Dr. Alexander. Dr. Gambs discussed professional education from the economic standpoint rather than the professional point of view.

Briefly, Dr. Gambs explained why engineering education particularly should, under the present economic condition, adhere to the law of supply and demand. The present condition indicates that there are many more engineers available than required and that therefore, the number of men entering this profession should be curtailed. The profession of law and medicine were examples of curtailment by means of increasing the number of years of study. The prospective engineering student should be made aware

of the fact that although an engineering education is a valuable experience, graduation from a course of this nature does not assure advancement in that profession nor should it necessarily be entered into for the purpose of becoming an engineer. Dr. Gambs also informed the Branch that our present economic order does not permit a man to enter the field for which he studied, but rather fits him into the place where he is needed whether he likes it or not.

The speaker was kept busy answering questions and discussing phases of his speech until Professor Entwisle found it necessary to intervene and call the meeting adjourned. It is felt that all who attended spent a profitable and interesting afternoon.

BOOK REVIEWS

Qualitative Chemical Analysis. RAY K. MCALPINE AND BYRON A. SOULE. Based on text by A. B. Prescott and O. C. Johnson, 69.6 pages. D. Van Nostrand Company, Inc., 250 Fourth Ave., New York, 1933; price $4.50.

While this book has been designed for the college student in analytical chemistry, its well-outlined material will make it a valued reference book in practice wherever such information is needed.

The first part deals with the principles of analytical chemistry. Special attention is given to recent theories in the field, and many references are given to the newer and more available literature. The information in the sections which deal with the properties, reactions and detection of the elements and compounds is presented in a well-organized form.

Detailed directions are given covering the analysis of twenty-three metals and eleven acid radicals other than the negative ions of the metals. Tables, charts and a complete index also contribute toward making a most usable book.

M. L. D.

Physical Mechanics. R. B. LINDSAY. D. Van Nostrand Co., New York, 1933, $4.00.

This is an excellent textbook on intermediate mechanics. It is suitable for those students who have had the first year of college physics and the two first years of college mathematics. No attempt has been made to dodge the use of the calculus, but where differential equations are used each step is fully explained.

One of the best features of this book is the attempt to give applications for the mechanical principles studied. For example, in the chapter on oscillatory motion there are sections on acoustical and electrical oscillations and the significance of the oscillator in atomic theory.

The physics teacher will be pleased by the large number of problems following the chapters as well as the more difficult list of supplementary problems at the end.

This book seems to be one of the most useful mechanics texts published and should be valuable to the engineer as well as the physicist, as the subject of statics is not neglected even though emphasis is on the more fundamental dynamics.

F. L. B., JR.

Principles and Practice of Electrical Engineering. By GRAY and WALLACE (Alexander Gray and G. A. Wallace). Fourth Edition, 538 pages, McGraw-Hill Book Company, Inc. Price $4.00.

This is a re-writing of the late Alexander Gray's book originally published in 1914, and revised in 1917, and 1924.

Many teachers of fundamental principles to beginning students have recognized the former editions of this book as one of the best in its field. The new revision is even better. The first five chapters are completely rewritten. New material has been injected throughout the book to bring it up to date.

The new book seems to be very well written. The subject matter is presented clearly and concisely with plenty of well chosen illustrations. There are 318 problems and questions located at the end of the book. The chapter on laboratory work has been unchanged. There are still 20 experiments listed. The book has been divided into forty-one chapters, beginning with matter and electricity, continuing with all the well recognized fundamentals up to some of the more recently recognized important subjects such as chapter 37, Converting and Rectifying Apparatus, and chapter 40 on Thermionic Tubes and Photoelectric Cells.

Considering the book as a whole, the field has been well covered with about fifty per cent of the material taken from the previous edition the other half includes revisions and additions to bring the book up to date. It will doubtless find a wider application in the teaching of "Principles and Practice" as a result of this new revision.

R. C. G.

"Principles of Industrial Organization." KIMBALL, DEXTER S. Fourth Edition, McGraw-Hill Book Co., New York, 1933.

The fourth edition of Dean Kimball's text titled "Principles of Industrial Organization," while making no radical changes from the previous editions, is, nevertheless, a greatly improved and more up-to-date book. The new form follows closely the general plan and subject arrangement of the preceding editions but new material has been added to supplement certain subjects and evidences of a thorough revision are found in the rewording of portions of the text wherein no change of subject matter is involved.

Kimball's book is remarkable from the standpoint of the variety of topics covered. Dealing with the principles involved in large scale manufacturing in general, the chapter discussions range from the history of the growth of our present system to individual treatments of the many phases of manufacturing. The transition from one subject to another has been skillfully made and a continuity at-

tained throughout the text which relates each sub-topic to the general field of study. Many subjects which might be expanded to book form such as wage payment plans, plant location and layout, personnel administration and cost finding are of necessity limited to one chapter of concisely stated facts, but greater elaboration cannot be expected in a text covering so wide a field as this.

A summary of the new material added to this book would give a picture of the advance in scientific management during recent years. Much progress has taken place in the fields of time and motion study and plant layout, so much new material has been added to these chapters in Kimball's book. The discussion of industrial growth has been elaborated and rearranged to present the facts more clearly. Several additional wage payment plans are given mention in the chapter of that heading and it thus becomes a more comprehensive discussion. No doubt our recent economic troubles account for the introduction of a short section entitled "Mechanization of Industry" which points out the new problems arising from the displacement of men by machines. Additional photographs, charts and diagrams help in modernizing this book and in maintaining its high position as an engineering text.

M. L.

Alternating Current Circuits. M. P. WEINBACH. First Edition, 417 pages, Macmillan. Price $4.50.

This new book presents a rational treatment of circuit theory. It should find its chief application as a text for alternating currents preceding the study of alternating current machinery.

The book is logically divided into 13 chapters. Numerous and fully worked out illustrative problems have been included with the development of theory. In addition to these problems others for the student have been inserted within the body of the book, and also a list of 76 problems for the 13 chapters is given at the end of the book.

The author has made a very timely use of the A. I. E. E.'s recent adoption of bold face letters to represent in print vector quantities. The method of solving unbalanced power systems by means of symmetrical phase components is well treated in chapter X.

The book impresses the writer as a high standard piece of work. He believes it is well in line with the latest trends and will prove to be a valuable text in the study of alternating current circuits.

R. C. G.

Vocational Guidance in Engineering Lines. Elicited and Edited by the American Association of Engineers. Editorial Committee: J. A. L. WADDELL, *Chairman*, FRANK W. SKINNER, HAROLD E. WESSMAN. 34 + 521 pp. 1933. The Mack Printing Co., Easton, Pa. Price $2.50.

The elaborate investigations in recent years by the Society for the Promotion of Engineering Education called so much attention to the related problems outside of the curriculum, personnel, and conditions of teaching, that the American Association of Engineers undertook the task of dealing with the prospective members of the profession before they begin their technical educational preparation. The result is the publication of a book "Vocational Guidance in Engineering Lines." It contains sixty chapters, the first nineteen covering a general treatment of the engineering profession, the seven main divisions of engineering, and some related topics like idealism, ethics, compensation, literature and journalism. One chapter is given specifically to vocational guidance, and another to ascertaining of mental capacity and special talents. Two chapters on consulting and contracting engineering respectively follow those on the main divisions. Forty chapters are devoted to forty specialties, or the closer subdivisions of engineering practice. Fifty half-tone illustrations of engineering construction are scattered throughout the text. In these chapters the description is adapted to the comprehension of young students and is combined with frequent references to the kind of work to be expected by the young graduate at the start and subsequently as experience is gained and capacity developed for advancement.

The primary purpose of this work is to encourage the most suitable of our country's youth to come into the engineering profession, and frankly to discourage unfit applicants for admission to the technical colleges. This treatise is intended to give to college students a fairly detailed description of the profession and its service in the life of mankind, and through its study and frequent review to stimulate their enthusiasm for the profession, as well as to arouse their mental powers to make the best use of the educational opportunity available.

The literary quality of this book is a good example of technical writing to both student and teacher, and should stimulate them to follow such models in whatever writing may form a part of their own work. Older engineers in practice may read the book with profit to supplement their knowledge of certain subdivisions or specialties, and to emulate these writers when composing their own professional reports, or contributions to society transactions or periodicals.

That high-school students, who wish to make an intelligent choice of a vocation, shall have no excuse for failing to obtain and read this book, the whole project is put upon an absolutely altruistic basis. Since its admirable contents are the fruit of so much concentrated time, thought and energy, all so freely given, and with such unselfish aims, this book should receive an appreciative welcome by educators and practicians alike, together with their hearty coöperation to speed the accomplishment of its mission.

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AMERICAN ENGINEERING COUNCIL

(Printed at the request of the American Engineering Council.)

The Treasury Department will look with much disfavor on those architects or engineers who retain legal counsel in Washington to aid them in securing professional contracts from the Department; in fact, it will be the disposition of the Department to eliminate such architects and engineers from consideration altogether. This announcement was recently made by Assistant Secretary of the Treasury Robert, who has requested the American Institute of Architects and American Engineering Council to make the attitude of his office widely known.

Early in the summer the Treasury Department learned that certain Washington lawyers had been soliciting engineers, architects, and others, interested in obtaining Government business, representing that to retain such counsel would enhance the opportunities of the engineers and architects to obtain desirable contracts. This activity has been particularly prevalent in western states.

The Treasury Department has not made the names of the lawyers who engaged in this practice public, feeling that probably they did not realize (1) that their proposal was in itself a reflection on certain Government officials; (2) that representation of the nature lawyers would provide could not possibly have any bearing upon the selections made by the Treasury Department.

The Department desires to make its selections on the merits of each case alone. There is no disposition on the part of the Department to prosecute any of the parties concerned, but it does want it emphatically understood that such a practice will be outlawed.